AMERICAN SOCIETY

FOR

TESTING MATERIALS

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

PROCEEDINGS

OF THE

EIGHTEENTH ANNUAL MEETING

Held at Atlantic City, New Jersey

June 22–26, 1915

VOLUME XV

PART I. COMMITTEE REPORTS

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SUMMARY OF THE PROCEEDINGS OF THE EIGHTEENTH ANNUAL MEETING.

ATLANTIC CITY, N. J., JUNE 22–26, 1915.

THE EIGHTEENTH ANNUAL MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS was held at the Hotel Traymore, Atlantic City, N. J., on June 22–26, 1915. The following is an analysis of the attendance at the meeting: Members, in attendance or represented, 435; guests, 68; ladies, 102; total, 605.

The following members were present or represented at the meeting:

A

Abbott, Robert R.
Abraham, Herbert,
  Ralph L. Shainwald, Jr.
Abrams, D. A.
Ackerman, Ernest R.
Adams, H. C.
Aertsen, G.
Aiken, W. A.
Ajax Metal Company,
  G. H. Clamer.
Akin, Thomas B.
Allentown Portland Cement Company,
  J. W. Fuller.
Alsen's American Portland Cement Works,
  Robert S. Sinclair.
Aluminate Patents Company,
  E. L. Conwell.
American Brass Company,
  William H. Bassett.
American Cement and Plaster Company,
  Edward Tupper.
American Foundrymen's Association,
  A. O. Backert.
American Institute of Architects,
  Thomas Nolan.
American Locomotive Company,
  S. V. Hunnings.
American Steel and Wire Company,
  S. M. Rodgers.
Anderson, Louis, Jr.
Armstrong, V. C.
Ashbridge, Richard I. D.
Ashton, Ernest.
Aupperle, James A.

B

Backert, A. O.,
  (*The Iron Trade Review*).
Baldwin Locomotive Works,
  H. V. Wille.
Barker, Edgar H.
Barrett Manufacturing Company,
  William S. Babcock.
Bates, P. H.
Baxter, Florus R.
Beale, Horace A., Jr.
Bear, Raymond R.
Berry, H. C.
Bethlehem Steel Company,
  E. O'C. Acker.
Betts, Harold S.
Bevier, P. H.
Bird, Robert M.
Bixby, W. H.
Blair, Will P.
Blakeley, Abraham G.
Blanchard, Arthur H.
Bleininger, A. V.
Boggs, Charles R.
Boyer, E. D.
Boynton, C. W.

Brighton Mills,
H. V. R. Scheel.
Brinton, F. H.
Brooks, Benjamin.
Brown, G. S.
Brown, H. J.
Brown, Richard P.
Browne, D. B.
Browne, Vere.
Brunner, John.
Buck, D. M.
Buffalo, Rochester and Pittsburgh Railway Company,
S. J. Wagar.
Bureau of Steam Engineering U. S. N., Engineering Experiment Station,
D. J. McAdam, Jr.
Burgess, George K.
Burnham, H. G.

C

Calumet Steel Company,
A. S. Hook.
Cambria Steel Company,
G. E. Thackray.
Camp, A. D.
Campbell, William.
Capp, J. A.
Carnahan, R. B., Jr.
Carnegie Institute of Technology,
F. M. McCullough.
Carnegie Steel Company,
C. F. W. Rys.
Carpenter Steel Company,
J. H. Parker.
Castner, Curran and Bullitt,
J. S. Burrows.
Cement Era,
G. D. Steele.
Central Foundry Company,
Harry Y. Carson.
Central Iron and Steel Company,
Robert H. Irons.
Cheesman, Frank P.
Christie, Alexander J.
Church, Sumner R.
Churchill, C. S.
Claiborne, Charles H.
Cobb, E. B.
Colby, Albert Ladd.
Colby, J. A.
Condit, E. A., Jr.
Conn, Charles F.
Conradson, P. H.
Coogan, F. M.
Cook, O. U.
Cooper, William A.
Corse, W. M.
Crawford, J. C.
Crescent Portland Cement Company,
O. C. Hasse.
Crew, J. A.
Cromwell, O. C.
Crume, W. H.
Cushman, A. S.

D

Dallis, Roy.
Dannerth, Frederic.
Davies, George C.
Davis, J. D.
Davis, Samuel D.
Detroit Steel Products Company,
M. P. Rummey.
Devoe, F. W., and C. T. Raynolds Company,
S. R. Fenton.
Dickinson, H. C.
Diller, H. E.
Douty, D. E.
Dow, A. W.
Drew, H.
Dunbar, W. O.
Dunn, B. W.
Dunn, W. R.
Dixon Crucible Company, Joseph,
M. McNaughton.

E

Eastern Paving Brick Manufacturers' Association,
Charles A. Young.
Edgerley, D. W.
Edwards, L. N.
Electrical Testing Laboratories,
F. M. Farmer.
Ellis, T. H.
Emley, Warren E.
Engineering Record,
E. J. Mehren.
Enright, Bernard.

F

Fackenthal, B. F.
Farran, William J.
Ferguson, Lewis R.
Fibre Shipping Container Association,
Thomas W. Ross.
Fieldner, A. C.
Fitch, Roy.
Flagg, Stanley, G., Jr.
Froehling and Robertson,
Carl Fleming.
Fleming, W. R.
Flowers, Alan E.

Force, H. J.
Forrest, C. N.
Forster, H. W.
Fort, Edwin J.
Fowler, George L.
French J. Hansell.
Fry, Lawford H.
Fulweiler, W. H.
Franklin Steel Company,
Edward E. Hughes.

G

Gage, Roscoe M.
Gardner, H. A.
Geiser, W. B.
General Electric Company,
J. A. Capp.
General Fire Proofing Company,
A. D. Neeld, Jr.
General Motors Company,
K. W. Zimmershield.
Geological Survey of New Jersey,
Robert B. Gage.
Gibboney, James H.
Gibbs, A. W.
Glasgow Iron Company,
James P. Roe.
Goldbeck, Albert T.
Goodell, John M.
Goodspeed, G. M.
Goodwin, Ralph E.
Grand Rapids Plaster Company,
A. H. Apted.
Greene, Hermann L.
Greenman, R. S.
Griffith, R. E.
Gulick, Henry.

H

Hagar, E. M.,
M. Metcalf.
Haigh, D. L.
Hall, Ellis B.
Hall, John H.
Harding, W. H.
Harrington, C. O., Jr.
Harrison and Schaffer,
H. A. Schaffer.
Hartranft, William G.
Hartshorne, William D.
Hartwell, S. W.
Hartzell, H. S.
Harvey, Dean.
Hatt, W. K.
Hay, J. Thomas.
Hagy Waste Works, The J. Milton,
Ralph L. Hays.
Hayward, H. W.
Heatley, Thomas.
Heckel, G. B.
Heckel, James E.
Hemstreet, George P.
Herschel, Winslow H.
Hess Bright Manufacturing Company,
G. S. Cope.
Hecks, Thomas A.
Hillebrand, William F.
Hilles, R. W.
Hilts, Harold E.
Hollow Building Tile Manufacturers' Association of America,
Charles T. Harris.
Holstein, L. S.
Hough, Norman G.
Howard, J. W.
Hubbard, Prévost.
Humphrey, Richard L.
Hunnings, S. V.

I

Ickes, E. T.
Illinois Central Railroad Company,
E. H. Bowser.
Illinois Steel Company,
P. E. Carhart.
Ingalls, F. P.
Inspection Department, Associated Factory Mutual Fire Insurance Company,
E. A. Barrier.
Interocean Oil Company,
Leroy M. Law.
Interstate Iron and Steel Company,
S. J. Llewellyn.
Iron Age, The,
E. F. Cone,
W. W. Macon.

J

Jackson, John L.
Jaquith, Horace J.
Jeffers, John M.
Jenckes Spinning Company,
Kenneth Moller.
Jennison, H. C.
Job, Robert.
Johnsen, A. M.
Johnson, A. L.
Johnson, A. N.
Johnson, G. A.
Johnson, Nathan C.
Jones, Jesse L.
Jones and Laughlin Steel Company
J. J. Shuman.
F. S. Slocum.
Jonson, Ernst.

K

Kaiser, Frank H.
Kanolt, C. W.
Kelley, T. W.
Kennedy, Frank G., Jr.
Kenney, E. F.
Kenney, L. H.
Kerr, C. H.
Kershaw, William H
Kiefer, Herman G.
Kinney, William M.
Koch, George B.
Kohr, D. A.

L

Lackawanna Steel Company,
F. E. Abbott.
La Forge, G. S.
Lane and Company, J. H.,
C. B. Finckel.
Lanza, Gaetano.
Larned, E. S.
Larsson, Emil.
Latta, Harrison W.
Leeds and Northrup Company, The,
Morris E. Leeds.
Lehigh Valley Railroad Company,
S. E. Printz.
Lenhart, J. M.
Lesh, Ira B.
Lesley, Robert W.
Linder, O.
Lindsay, R. W.
Little, Incorporated, A. D.,
J. C. Callan.
Lober, John B.
Lothrop, M. T.
Lowe Brothers Company, The,
D. A. Kohr.
Lunn, C. A.
Lynch, T. D.
Lucas and Company, Incorporated, John,
L. P. Nemzek.
Lumen Bearing Company,
N. K. B. Patch.

M

MacFarland, H. B.
Macgregor, James S.
MacGregor, John R.
Mackenzie, K. G.
MacPherran, R. S.
Maitland, Harold.
Marble, Edwin H.
Marburg, Edgar.
Marion Steam Shovel Company,
R. A. Young.
Marsh, C. P.
Masters, F. M.
Masury and Sons, John W.,
F. P. Ingalls.
Mathews, John A.
Mattimore, Horatio S.
McDonnell, M. E.
McIlhiney, Parker C.
McIntyre, W. A.
McKelvy, F. G.
McNaugher, D. W.
Mead, Charles A.
Meade, Richard K.
Merriman, Mansfield.
Midvale Steel Company,
Radclyffe Furness.
Miller, R. P.
Miner, Joshua L.
Moldenke, Richard.
Moore, G. W.
Moore, Henry A.
Moore, H. F.
Morrow, James G.
Morton, Lindley C.
Moyer, Albert.
Murphy Varnish Company,
W. F. Burleigh.
Myers, J. E.

N

Nash, James P.
National Fire Proofing Company,
Ralph W. Allison.
National Tube Company,
G. M. Goodspeed.
G. P. McCliff.
Neale, Laurance I.
Newlin, J. A.
New Jersey Zinc Company,
Gilbert Rigg.
George C. Stone.
New York Central Railroad Company,
A. W. Carpenter.
Newport News Shipbuilding and Dry Dock Company,
John W. Gray.
Norris, George L.
Norton Company,
Ross C. Purdy.

O

Olson, L. W.
Orton, Edward, Jr.
Olsen, Tinius,
T. Y. Olsen.
Olsen, T. Y.

P

Page, L. W.
Palmer, P. S.
Pease, Burton H.
Peerless Motor Car Company,
Robert R. Abbott.
Pennsylvania State Highway Department,
Joseph W. Hunter.
Perfection Spring Company,
Z. B. Leonard.
Perry, Robert S.,
W. J. Grubb.
Petinot, N.
Pickard, Glenn H.
Pittsburgh Testing Laboratory,
John M. Bailey.
James O. Handy.
Porter, J. Madison.
Potts, S. C.
Pressell, G. W.
Price, William B.
Provost, A. J., Jr.
Pullar, H. B.

Q

Quimby, Henry H.

R

Railway Steel Spring Company,
George Hargreaves.
Randall, Theodore A.,
(*Clay Worker*).
Raquet, E. H.
Ray, G. J.
Reading, Iron Company,
George Schuhman.
Register, Frank M.
Reihle, Frederick A.,
W. J. Tretch.
Reinhardt, G. A.
Remington Arms and Ammunition Company,
N. A. Chase.
Reninger, Henry A.
Rex, G. E.
Rhode Island Tool Company,
Arthur H. Annan.
Rich, Charles H.
Richardson, Clifford.
Rigg, E. H.
Rigg, Gilbert.
Rights, Lewis D.
Rinald, C. D.
Ritter, Daniel G.
Robinson, A. F.
Rock Products,
F. K. Irvine.
Rodgers, S. M.
Rodman, H. B.
Roeblings Sons Company, J. A.,
H. J. Horn.
Rogers, R. E.
Royle and Sons, J.,
V. E. Royle.
Rys, C. F. W.

S

Sabin, A. H.
Savage, H. D.
Schaeffer, J. A.
Schall, F. E.
Schermerhorn, E. F.
Schmitt, F. E.,
(*Engineering News*).
Scott and Company, H. L.,
H. L. Scott.
Seaton, Max Y.
Security Cement and Lime Company,
L. A. Cover.
Sharples, P. P.
Shelley, H. T.
Shuman, J. J.
Skinner, H. J.
Slater, W. A.
Slocum, F. S.
Smith, E. B.
Smith, F. P.
Smith, H. E.
Smith, J. Hammond.
Smither, F. W.
Spackman Engineering Company, H. S.,
H. S. Spackman.
Spare, C. R.
Spencer, H.
Stafford, S. G.
Stalknecht, A. C.
Standard Steel Works Company,
Lawford H. Fry.
A. A. Stevenson.
Standard Underground Cable Company,
G. D. Eustachio.
Sterling, E. A.
Stevenson, A. A.
Stone, George C.
Swain, George F.
Sweetser, R. H.
Swett, B. L.

T

Tagliabue, C. J.
Talbot, A. N.
Taylor, Arthur P.

Taylor, C. Marshall.
Taylor, Knox,
A. S. Hummell.
Taylor Instrument Companies,
E. N. Hurlburt.
Testing Laboratory of the City of St. Louis,
Mont Schuyler.
E. P. Withrow.
Texas Rolling Mill Company,
C. Barney Smith.
Thompson, Gustave W.
Thompson, Sanford E.
Titanium Alloy Manufacturing Company,
W. F. Meredith.
Topping, W. S.
Trautwine, John C., Jr.
Tretch, W. J.

U

Uhler, J. Lloyd.
Unger, J. S.
United Gas Improvement Company,
W. H. Fulweiler.
United States Gutta Percha Paint Company,
Herbert W. Rice.
United States Gypsum Company,
Virgil G. Marani.
Universal Portland Cement Company,
Robert F. Hall.

V

Vanderpoel, William K.
Vassar, H. S.
Veitch, F. P.
Victor Talking Machine Company,
Edwin F. Hicks.
Virginia Bridge and Iron Company,
J. K. Graham.
Von Schrenk, H.
Voorhees, S. S.
Vredenburgh, Watson, Jr.

W

Wagner, Samuel T.
Walter, L. W.
Waring, F. M.
Warner, Charles.
Warwick, C. Laurence.
Walker, Percy H.
Warner-Quinlan Asphalt Company,
William C. Monsell.
Wason, Leonard C.
Watkinson, George.
Weaver, R. S.
Webb, S. G.
Webster, G. S.
Webster, Maurice A.
Weiss, John Morris.
Welty, H. T.
Wetherill, C. T.,
P. J. Whiteway.
Westinghouse, Church, Kerr and Company,
Cloyd M. Chapman.
Westinghouse Electric and Manufacturing Company,
T. D. Lynch.
White, G. D.
Wickhorst, M. H.
Wig, R. J.
Wight, Frank C.
Wille, H. V.
Wilson, Edwards F.
Wilson, Percy H.
Wood, Edwin T.
Wood, Walter.
Woodroffe, G. H.
Woolson, Ira H.
Worcester, J. R.
Wormeley, P. L.

Y

York Manufacturing Company,
Charles H. Ehrenfeld.
Yost, C. W.
Young, C. D.
Young, J. Bertram.
Youngstown Sheet and Tube Company,
E. T. McCleary.

Z

Zeidler, John L.
Zeleny, Frank.
Zimmerschied, K. W.

FIRST SESSION—TUESDAY, JUNE 22, 11 A. M.

President A. W. Gibbs in the chair.

The minutes of the Seventeenth Annual Meeting were approved as printed.

The Secretary-Treasurer presented the annual report of the Executive Committee. On motion, the proposed amendments of the following sections of the by-laws were referred to letter ballot of the Society:

Article III, Sections 2 and 6, and Article VI, Section 1.

Final action on the proposed amendments of Article I, Sections 2 and 3; Article VII, Section 1; and Article VII, Section 3, was deferred pending a report from a committee consisting of the members of the incoming and outgoing Executive Committees, which was charged to consider the financial question in all its phases and to report its findings to the Society at the opening of the fifth session, the expressed sense of the meeting being that no backward step should be taken.

In the absence of Mr. C. E. Skinner, Chairman of Committee D-9 on Standard Tests of Insulating Materials, the report of that committee was presented by the Secretary-Treasurer.

The reports of Committee E-5 on Technical Committees, and of Committee E-6 on Papers and Publications were introduced by Mr. Edgar Marburg, Chairman of these committees.

The tellers, Mr. C. L. Warwick and Mr. F. M. Register, on the election of officers, reported that 665 legal ballots had been cast, which had resulted in the unanimous election of the following officers: Mr. Mansfield Merriman, President; Genl. W. H. Bixby, Vice-President; Mr. J. H. Gibboney, Mr. W. K. Hatt, Mr. J. A. Mathews and Mr. Edward Orton, Jr., Members of Executive Committee.

The Secretary-Treasurer reported the receipt of a telegram from Past-President Robert W. Hunt, expressing his regret that at the eleventh hour he had found himself unable to attend the annual meeting.

Mr. Mansfield Merriman, the President-elect, was then introduced by the Chairman and offered a few remarks expressive

of his appreciation of the honor conferred upon him, and pledging his endeavor to promote the best interests of the Society.

The meeting then adjourned till 3 P. M.

SECOND SESSION—TUESDAY, JUNE 22, 3 P. M.

Genl. W. H. Bixby in the chair.

In the absence of Mr. S. V. Hunnings, Chairman of Committee A-2 on Standard Specifications for Wrought Iron, the report of that committee was presented by Mr. F. M. Waring. On motion, it was decided to refer the proposed Standard Specifications for Iron and Steel Chain to letter ballot of the Society.

The Chairman then called upon Mr. Richard Moldenke, Chairman of Committee A-3 on Standard Specifications for Cast Iron and Finished Castings, to introduce the report of that committee.

Mr. Moldenke stated that before presenting that report he felt it his painful duty to announce the recent death under tragic circumstances of Mr. Thomas D. West, a valued member of the committee and of the Society, and at his suggestion the assembly rose in token of respect.

On motion, the proposed revised Standard Specifications for Malleable Iron Castings were referred to letter ballot of the Society.

The proposed Standard Methods for Sampling and Analysis of Pig and Cast Iron (for Export) were, on motion, amended (1) by changing the title to read "Tentative Methods for Sampling and Analysis of Pig and Cast Iron," and (2) by inserting the following sentence immediately after the heading "Subsequent Treatment of Sample from both Pig and Castings": "In the determination of total and graphitic carbon, and in the case of check analyses on the other constituents, the following precautions shall be taken." As thus amended these proposed Methods were accepted for publication among the Tentative Standards in the Year Book.

In the absence of Mr. J. A. Holmes, Chairman of Committee D-5 on Standard Specifications for Coal, the report of that committee was presented by Mr. J. D. Davis. On motion,

the proposed Tentative Method for Sampling of Coal was accepted for publication among the Tentative Standards in the Year Book.

The report of Committee D-6 on Standard Specifications for Coke, was, in the absence of the Chairman, Mr. J. A. Holmes, presented by Mr. A. C. Fieldner, Secretary of the committee. On motion, the proposed Tentative Specifications for Foundry Coke were accepted for publication among the Tentative Standards in the Year Book.

In the absence of Mr. S. W. Parr, Chairman of Committee E-4 on Methods of Sampling and Analysis of Coal, the report of that committee was presented by Mr. W. F. Hillebrand. On motion, the proposed Tentative Methods for Sampling and Analysis of Coal were accepted for publication among the Tentative Standards in the Year Book, with the understanding that the committee will be permitted to make certain minor changes in wording and other details, including the insertion of the word "Laboratory" before "Sampling" in the title, with a view of avoiding confusion with the Tentative Method for Sampling of Coal, reported by Committee D-5.

A paper on "The Fusibility of Coal Ash," by Messrs. A. C. Fieldner, A. E. Hall and A. L. Feild, was presented by Mr. Fieldner and discussed.

The meeting then adjourned till 8 P. M.

THIRD SESSION—TUESDAY, JUNE 22, 8 P. M.

On Non-Ferrous Metals.

President-elect Mansfield Merriman in the chair.

The Presidential Address entitled "Our Rail Specifications" was delivered by the retiring President, Mr. A. W. Gibbs.

The report of Committee B-1 on Standard Specifications for Copper Wire was presented by Mr. J. A. Capp, Chairman.

On motion, the proposed revisions in the Standard Specifications (1) for Hard-Drawn Copper Wire, (2) for Medium Hard-Drawn Copper Wire, and (3) for Soft or Annealed Copper Wire, were referred to letter ballot of the Society. The pro-

posed Tentative Specifications for Bare Concentric-Lay Copper Cable: Hard, Medium-Hard, or Soft, and the proposed Tentative Specifications for High-Strength Bronze Trolley Wire, Round and Grooved: 40 and 65-per-cent Conductivity, were accepted for publication among the Tentative Standards in the Year-Book.

The report of Committee B-2 on Non-Ferrous Metals and Alloys was introduced by Mr. William Campbell, Chairman, who called attention to the following errors in the proposed Standard Specifications for the Alloy, Copper, 88 per cent; Tin, 10 per cent; Zinc, 2 per cent: (1) In Section 3, change the percentage of copper from 87–89 to 86-89; and (2), in the second sentence of Section 8, change "each shall select a sample" to "they shall select the sample." In view of certain criticisms of these proposed Standard Specifications, it was decided to accept them for publication among the Tentative Standards in the Year-Book.

The following papers were then read and discussed:

"Fatigue of Copper Alloys," by Mr. Ernst Jonson.

"Battery Zincs—Some Causes of Defective Service," by Mr. Robert Job and Mr. F. F. White.

"The Determination of Spelter Coating on Sheets and Wire," by Mr. J. A. Aupperle.

The meeting then adjourned till the following morning.

FOURTH SESSION—WEDNESDAY, JUNE 23, 10 A. M.

On Steel.

President A. W. Gibbs in the chair.

The report of Committee A-1 on Standard Specifications for Steel was presented by Mr. C. D. Young, Chairman.

The following action was taken on the various features of this report, the amendments noted having been reported by Mr. Young as having been agreed to at a recent meeting of Committee A-1.

To refer to letter ballot of the Society:

I. PROPOSED REVISIONS IN PRESENT STANDARDS:

Standard Specifications for:

Structural Steel for Bridges.

Automobile Carbon and Alloy Steels—amended as follows:

(*a*) In Table III, under the last heading "With 3.50 per cent Nickel," add the following grade:

Carbon: Desired..... 0.30 per cent.
Permissible Range: 0.25–0.35 "
All other properties the same as those of the two present grades.

(*b*) In Table V, change the phosphorus requirement of the last grade of steel from 0.04 0.03 per cent.

II. PROPOSED NEW STANDARDS.

Proposed Standard Specifications for:

Lap-Welded and Seamless Boiler Tubes for Stationary Service.

Welded Steel and Wrought-Iron Pipe.

Quenched High-Carbon-Steel Splice Bars—amended as follows:

(*a*) In the title, change "heat-treated" to "quenched."

(*b*) In Section 2, change "heat-treated" to "quenched."

(*c*) In Section 3, change the percentage of carbon from "not under 0.40 per cent" to "not over 0.60 per cent."

Quenched Carbon-Steel Track Bolts—amended as follows:
In the title, change "heat-treated" to "quenched."

Quenched Alloy-Steel Track Bolts—amended as follows:
In the title, change "heat-treated" to "quenched."

Proposed Standards Methods for:

Chemical Analysis of Alloy Steels.

In connection with the consideration of the proposed Tentative Specifications for Silico-Manganese-Steel Bars for Automobile and Railway Springs, and for Chrome-Vanadium-Steel Bars for Automobile and Railway Springs, Mr. C. F. W. Rys moved that in the footnotes to Sections 6 (*a*) the words "for automobile springs" be changed to "for automobile and railway springs," and that the tables in Section 6 (*b*) with reference to permissible variations in gage and width of bars for railway springs be omitted. This motion was lost.

A motion by Mr. J. J. Shuman that in the footnotes above referred to the words "for automobile springs" be changed to "for automobile and railway springs" was carried.

The following proposed Tentative Standards were then accepted for publication among the Tentative Standards in the Year-Book:

III. PROPOSED TENTATIVE STANDARDS.

Specifications for:

Carbon-Steel Bars for Vehicle and Automobile Springs.

Silico-Manganese-Steel Bars for Automobile and Railway Springs—amended as follows:

> In the footnote to Section 6 (*a*), change "for automobile springs" to read "for automobile and railway springs."

Chrome-Vanadium-Steel Bars for Automobile and Railway Springs—amended as follows:

> In the footnote to Section 6 (*a*), change "for automobile springs" to read "for automobile and railway springs."

Helical and Elliptical Springs for Railways.

Alloy-Steel Forgings.

Quenched-and-Tempered Alloy-Steel Axles, Shafts and other Forgings for Locomotives and Cars.

Mr. Young called attention to the following misprints in the report of Committee A-1:

1. Under the heading "Miscellaneous Announcements," change "steel spikes" to read "screw spikes."

2. In the proposed Standard Specifications for Carbon-Steel Track Bolts and for Alloy-Steel Track Bolts, Section 11, line 4, change "bottom" to "body."

3. In the proposed Tentative Specifications for Alloy-Steel Forgings, Table I, change the percentage of elongation of Class K forgings over 2 to 4 in. in outside diameter from zero to 20.

Mr. Young reported that Committee A-1 was giving consideration to a new table for permissible variations in weight and gage of sheared plates, on which they expected to make a formal report in due course.

The report on Finishing Temperatures of Rails, appended to the report of Committee A-1, was then discussed, this discussion being closed by Mr. Young with the statement that the criticisms of Mr. G. K. Burgess had already been brought to the notice of Committee A-1 and that they had been referred to Sub-Committee I on Steel Rails and Accessories, "with instructions to prepare an adequate reply for publication in the Proceedings, and to give serious consideration to the invitation extended by Mr. Burgess for cooperation with the committee."

The report of Committee A-8 on Standard Specifications for Cold-Drawn Steel was presented by the Secretary-Treasurer, in the absence of Mr. C. E. Skinner, Chairman.

On motion the proposed Standard Specifications for Cold-Drawn Steel: Open-hearth Automatic Screw Stock, were referred to letter ballot of the Society.

The report of Committee E-1 on Standard Methods of Testing was introduced by the Chairman, Mr. Gaetano Lanza.

On motion, it was decided to refer Sections I, II and V to letter ballot of the Society, Section I relating to proposed Standard Methods for Brinell Hardness Tests of Metals, and Sections II and V embracing changes in the present Standard Methods of Testing.

It was further voted to accept Sections III and IV for publication among the Tentative Standards in the Year-Book.

The following papers were then presented by their authors and discussed:

"Elastic Limit," by Mr. T. D. Lynch.

"Molten Zinc as a Reagent for Etching in the Macroscopic Examination of Steel," by Mr. Jesse L. Jones.

The meeting then adjourned till 8 P. M.

FIFTH SESSION—WEDNESDAY, JUNE 23, 8 P. M.

On Heat Treatment of Steel.

Vice-President A. A. Stevenson in the chair.

The Chairman announced that in pursuance of instructions the special committee consisting of the members of the outgoing and incoming Executive Committees, which had been charged at the first session to report at this session on the general subject of finances, would now present its report through the Secretary-Treasurer. The Secretary-Treasurer announced on behalf of this committee that it had taken under careful consideration the various possible measures embodied in the annual report of the Executive Committee and others, and that it had reached a conclusion in agreement with the sense of the Society as expressed at the first session that no backward step should be taken. The committee would accordingly suggest the amendment of the by-laws to the effect of increasing the annual dues for Members from $10 to $15, for Junior Members from $5 to $7.50, and the cost of membership in perpetuity from $200 to $300, with the understanding that if these proposed amendments should be approved at this meeting and on subsequent letter ballot, they shall not become effective till January 1, 1916.

On motion, the Executive Committee was authorized to submit proposed amendments to the above effect to action by letter ballot of the Society.

The Chairman announced that another engagement would oblige him to relinquish the chair and invited Mr. J. A. Capp to take his place.

Mr. Capp accordingly assumed the chair.

The following papers were then read by their respective authors and discussed:

"Internal Stresses Developed by Different Quenching Mediums and Their Effects," by Mr. H. V. Wille.

"The Relation between Maximum Strength, Brinell Hardness and Scleroscope Hardness in Treated and Un-Treated Alloy and Plain Steels," by Mr. Robert R. Abbott.

"Some Neglected Phenomena in the Heat Treatment of Steel," by Mr. M. E. Leeds.

In the absence of the author, Mr. J. G. Ayers, Jr., his paper on "Micrographic Determination of Surface Decarburization in Heat-Treated Steels" was presented in abstract by Mr. G. K. Burgess.

A paper on "The Charpy Impact Test on Heat-Treated Steels," by Lieutenant J. J. Thomas, was, in the absence of the author, read by title.

The meeting then adjourned till the following morning.

SIXTH SESSION—THURSDAY, JUNE 24, 10 A. M.

On Testing Apparatus.

President A. W. Gibbs in the chair.

A paper on "The Failure of Materials under Repeated Stress," by Mr. H. F. Moore and Mr. F. B. Seely, was presented by Mr. Moore and discussed.

A paper on "A Laboratory Method of Determining Pressures on Walls and Bins" was introduced by its author, Mr. J. Hammond Smith, and discussed.

A paper on "A Universal Strainometer of Simple Design" was, in the absence of the author, Mr. S. H. Graf, read by title.

Mr. C. D. Young then presented his paper on "The New Physical and Chemical Laboratory of the Pennsylvania Railroad Company at Altoona," which was illustrated by means of numerous lantern slides.

After the discussion of this paper Mr. S. S. Voorhees, Chairman of Committee A-5 on the Corrosion of Iron and Steel, presented an informal report on behalf of that committee which, as he explained, had been approved by the majority of the members of Committee A-5 at a meeting held on the previous day, and which would be subject to approval of the committee at large by letter ballot.

The meeting then adjourned till 3 P. M.

SEVENTH SESSION—THURSDAY, JUNE 24, 3 P. M.

On Cement and Concrete.

Past-President A. N. Talbot in the chair.

The report of Committee C-1 on Standard Specifications for Cement was presented in the absence of the chairman, Mr. G. F. Swain, by the Secretary, Mr. Richard L. Humphrey.

Mr. Humphrey reported that at a recent meeting Committee C-1 had decided to supplement its report by calling attention to the following two motions adopted at that meeting:

> "That the report of the Joint Conference be received and referred to suitable sub-committees of Committee C-1, to investigate and report; said sub-committees to be appointed in accordance with the following rule of the committee:
>
> > Art. II, Sec. 2.—Sub-committees proposed by the committee shall be appointed by the Advisory Committee subject to final ratification by the committee.
>
> "That the Executive Committee of the American Society for Testing Materials be asked to confer with the Board of Direction of the American Society of Civil Engineers and suggest that they withhold from general publication the Joint Conference report until Committee C-1 has had a sufficient opportunity (not longer than one year) to consider the report."

The report of Committee C-9 on Standard Tests of Concrete and Concrete Aggregates was presented by Mr. S. E. Thompson, Chairman.

After the discussion of this report the following papers were presented by their respective authors and discussed:

"Microstructure of Concretes," by Nathan C. Johnson.

"The Effect of Finer Grinding and a Higher SO_3 Content upon the Physical Properties of Portland Cement," by P. H. Bates.

The following papers were, in the absence of the authors, read by title:

"An Investigation of the Strength and Elastic Properties of Concrete-Filled Pipe Columns," by Mr. F. W. Swain and Mr. A. F. Holmes.

"Weight-Volumetric Proportioning of Concrete-Aggregates in Testing," by Mr. J. A. Kitts.

The meeting then adjourned till the following morning.

EIGHTH SESSION—FRIDAY, JUNE 25, 10 A. M.

On Ceramics, Gypsum and Lime.

Mr. Edward Orton, Jr., in the chair.

The report of Committee C-3 on Standard Specifications for Brick was presented by Mr. A. V. Bleininger, Chairman.

On motion, the proposed Standard Specifications for Paving Brick were referred to letter ballot of the Society.

The report of Committee C-4 on Standard Tests and Specifications for Clay and Cement Sewer Pipes was, in the absence of the Chairman, Mr. Rudolph Hering, introduced by the Vice-Chairman, Mr. A. J. Provost.

It was moved that the proposed Tentative Recommended Practice for Laying of Sewer Pipe be accepted for publication among the Tentative Standards in the Year-Book, and that the proposed Standard Definitions of Terms Relating to Sewer Pipe be referred to letter ballot of the Society with the modification of the definition of the term "Vitrification" by changing the words "Fusion into a hard glassy material under high heat"

to "Consolidation of material under high heat."[1] This motion was carried with the amendment that the committee which has now under consideration the question of introducing reference to matters of engineering design and construction in the Standards of the Society as exemplified in the Standards introduced last year by Committee C-6 on Standard Tests and Specifications for Drain Tile, which committee consists of the Executive Committee and Committee C-6, be increased by the addition of Committee C-4, so that the report which this committee is expected to present next year may have received previous consideration by Committee C-4 as well as Committee C-6.

The report of Committee C-6 on Standard Tests and Specifications for Drain Tile was, in the absence of the Chairman, Mr. A. Marston, presented by Past-President Talbot.

The Chairman then invited Past-President Talbot to assume the chair during Mr. Orton's presentation of his paper on "The Legal Interpretation of the Word 'Vitrified' as Applied to Ceramic Products."

On motion the definition of the term "Vitrification" was referred to Committee C-3 on Standard Specifications for Brick, with instructions to confer with the other technical committees dealing with clay products.

The report of Committee C-7 on Standard Specifications for Lime was introduced by Mr. J. S. Macgregor, Chairman.

Following the presentation of this report a five-minute recess was taken in order to enable the members of Committee C-7 present to consider a written criticism of the specifications by Mr. W. C. Hanna.

After the meeting had reassembled, the proposed Standard Specifications for Quicklime and the proposed Standard Specifications for Hydrated Lime, as presented by Committee C-7, were referred to letter ballot of the Society.

The report of Committee C-11 on Standard Specifications for Gypsum and Gypsum Products was introduced by Mr. R. J. Wig, Chairman, and discussed.

The meeting then adjourned till 3 P. M.

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[1] This modification was proposed by the committee in presenting its report.—ED.

NINTH SESSION—FRIDAY, JUNE 25, 3 P. M.

On Preservative Coatings and Lubricants.

Mr. G. W. Thompson in the chair.

The report of Committee D-1 on Preservative Coatings for Structural Materials was presented by P. H. Walker, Chairman. Mr. Walker reported that at a recent meeting of Committee D-1 it was agreed to recommend certain amendments to the report. The amendments affecting proposed Standards or Tentative Standards are given below in their appropriate places. In addition, the committee recommended that the Summary at the end of the Report of Sub-Committee X on Inspection of White-Paint Test Fence at Washington, D. C., be replaced by the following:

> "The indications from this inspection are similar to those outlined in the summary of the report presented at the last annual meeting. The panels painted with composite paints containing both zinc and lead pigments show superiority to those painted with single primary pigments.
>
> "Attention is called to some apparent inconsistencies between reports of inspections of 1914 and 1915. It is believed that they are largely due to the difficulty of attaching a precise meaning to the terms used. It is the intention of the sub-committee to attempt to standardize the terms employed in paint inspections.
>
> "It is the opinion of the sub-committee that these tests have afforded information of great value.
>
> "It is recommended that these tests be discontinued, allowing the fence to stand or the panels otherwise cared for, and that another series of paint tests be considered which may include repainting of some of the old panels.
>
> "A report[1] from Miss Vera K. Charles, Assistant Mycologist, Bureau of Plant Industry, Department of Agriculture, covering a preliminary investigation of the organic life present on the paints, appears as an appendix to this report.

[1] See pp. 257–258.—ED.

On motion these amendments were approved.

On motion the following action was taken on various features of the report:

To refer to letter ballot of the Society:

I. PROPOSED REVISIONS IN PRESENT STANDARDS.

Standard Specifications for:

Purity of Raw Linseed Oil from North American Seed.

II. PROPOSED NEW STANDARDS.

Proposed Standard Specifications for:

Purity of Raw Chinese Wood Oil.

Purity of Boiled Linseed Oil from North American Seed.

Turpentine—amended as follows:

(*a*) In Section 2, change "shall" to "may," and omit the comma after "gum." Omit the marginal note "Appearance."

(*b*) In Section 3, add "or better" after "Standard."

(*c*) In Section 9, add "or better" after "Standard."

Proposed Standard Definitions of:

Terms Used in Paint Specifications—amended as follows:

Insert an explanatory note under the definition of "Gallon" reading: "This is the standard United States gallon."

To accept for publication among the Tentative Standards in the Year-Book:

III. PROPOSED NEW TENTATIVE STANDARDS.

Proposed Tentative Tests for:

Distillation of Paint Thinners other than Turpentine.

Moisture in Bleached Shellac—amended as follows:

Under Method No. 1, transpose the second and third sentences.

Proposed Tentative Methods for:

Routine Analysis of White Pigments—amended as follows:

(*a*) Under the heading "Zinc-Lead and Leaded-Zincs (Ozlo White)," change the last sentence in the

first paragraph on "Total Lead and Zinc" to read as follows:

"Make filtrate from $PbSO_4$ alkaline with NH_4OH, then acid with HCl, add 3 cc. of concentrated HCl, heat to nearly boiling, and titrate the total zinc with potassium-ferrocyanide solution using uranium-acetate solution as an outside indicator and calculate to ZnO. (Iron, copper, or other interfering substances should be first removed as described by Low.)"

(*b*) Under "Soluble Zinc Sulfate," change "Boil" to "Heat nearly to boiling."

(*c*) Under "Sulfur Dioxide," after "Basic Sulfate of Lead" add the words "or Zinc Oxide."

(*d*) Under the heading "Lithopone," insert as a paragraph just above the paragraph headed "Zinc Sulfide" the following:

"*Zinc Oxide.*—Treat a 4-g. sample of the lithopone for 4 hours with 200 cc. of 1-per-cent acetic acid at room temperature, stirring occasionally. Filter by suction on a double filter paper and wash with cold water; add to the clear filtrate 13 cc. of concentrated NH_4OH, neutralize with HCl and then add 3 cc. of concentrated HCl in excess. Heat to boiling and titrate with $K_4Fe(CN)_6$, using uranium-acetate solution as an outside indicator. Calculate to ZnO. Calculate this result to Zn, subtract from total Zn, and calculate the difference to ZnS. (Any $ZnCO_3$ or $ZnSO_4$ is included in the ZnO.)"

The report of Committee D-2 on Standard Tests for Lubricants was presented, in the absence of the Chairman, Mr. C. P. Van Gundy, by Mr. P. H. Conradson, Vice-Chairman.

Mr. M. E. McDonnell moved that the majority and minority reports of the committee be accepted for publication in the Procedings and that the proposed Standard Tests for Lubricants be referred back to the committee for such further investigations concerning items on which the committee is not in agreement

as it may see fit to undertake. After considerable discussion this motion was carried by a vote of 21 ayes and 7 nays.

Mr. Alan E. Flowers moved that Committee D-2 be instructed "that viscosity values shall be stated in terms of absolute viscosity." At the suggestion of the Secretary-Treasurer, Mr. Flowers accepted the amendment that this matter be referred to the Executive Committee for such action as it may see fit to take.

A paper on "A Cylinder Friction and Lubrication Testing Apparatus," by Mr. Alan E. Flowers, was presented by its author and discussed.

The meeting then adjourned till the following morning.

TENTH SESSION—SATURDAY, JUNE 26, 10 A. M.

On Road Materials, Timber and Rubber.

President A. W. Gibbs in the chair.

The report of Committee D-11 on Standard Specifications for Rubber Products was presented by Mr. E. A. Barrier, Chairman. On motion, the proposed Standard Specifications for $2\frac{5}{8}$-in. Cotton Rubber-Lined Fire Hose for Private Department Use, and the proposed Standard Methods for Testing of Cotton Rubber-Lined Hose were referred to letter ballot of the Society.

In presenting the proposed Tentative Specifications for Insulated Wire and Cable: 30 per cent Hevea Rubber, it was explained that this part of the report had not been completed in time to admit of preprinting and that it had, therefore, not been seen by members of the Society, except those connected with the committee. On motion it was accordingly decided to print these proposed tentative specifications in the Year-Book among the Tentative Standards, provided an early proposed letter ballot of Committee D-11 should be in the affirmative without a dissenting vote.[1]

Mr. Frederic Dannerth moved that no specifications shall

[1] The letter ballot was not unanimous, so that the proposed Tentative Standards have not been printed in the Year-Book. They appear on pp. 411–433.—ED.

contain any discrimination between two or more materials unless such specifications contain a method of distinguishing these materials. At the suggestion of the Secretary-Treasurer, Mr. Dannerth agreed to the amendment of this motion that the matter be referred jointly to the Executive Committee and Committee E-5 on Technical Committees. The motion as thus amended was carried.

The report of Committee D-4 on Standard Tests for Road Materials was then presented by Mr. Prévost Hubbard, Secretary.

Mr. Hubbard moved that the proposed Standard Definitions of Terms Applicable to Materials Relating to Roads and Pavements, appended to the report, be referred to letter ballot of the Society. Mr. W. A. Aiken proposed to amend this motion by omitting the proposed definitions for Solid Bituminous Materials, Liquid Bituminous Materials and Semi-Solid Bituminous Materials. This amendment was not accepted by Mr. Hubbard and was lost. A proposed amendment by Mr. L. R. Ferguson that the word "stone" be omitted in the proposed definition of Crusher-Run was also lost. Mr. Hubbard's motion was then carried.

On motion of Mr. L. W. Page, the definitions of the following terms were referred to Committee D-4 on Standard Tests for Road Materials and Committee C-9 on Standard Tests of Concrete and Concrete Aggregates for consideration: Aggregate, Bank Gravel, Clay, Filler, Gravel, Grit, Loam, Sand, Screen, Screenings, Sieve and Silt; and the definitions of the following terms were withdrawn for consideration by Committee D-4: Ashes, Binders, Cinders and Macadam.

A paper on "Some Experiments on Technical Bitumens," by Mr. S. R. Church and Mr. John Morris Weiss, was then presented by Mr. Weiss and discussed.

The report of Committee D-7 on Standard Specifications for Timber was introduced by Mr. Hermann von Schrenk, Chairman, on whose motion the proposed revisions in the Standard Classification of Structural Timber, and the proposed Revised Standard Specifications for Yellow-Pine Bridge and Trestle Timbers, were referred to letter ballot of the Society.

Mr. F. E. Schmitt called attention to an inconsistency in

the wording of the closing sentence in Sections 7 (*b*) and 8 (*b*) of the proposed revised Standard Specifications for Yellow-Pine Bridge and Trestle Timbers, the closing sentence of Section 7 (*b*) being "Ring shakes extending not over one-eighth the length of the piece are admissible," and that of Section 8 (*b*) being "Ring shakes shall not extend over one-eighth of the length of the piece." On motion, and with the approval of the Chairman of the committee, the former sentence was changed to conform with the latter.

On motion, the proposed Tentative Specifications for Southern Yellow-Pine Timber to be Creosoted, the proposed Tentative Specifications for Southern Yellow-Pine Piles and Poles to be Creosoted, and the proposed Tentative Methods for Sampling and Analysis of Creosote Oil were accepted for publication among the Tentative Standards in the Year-Book.

A paper on "A Fungus Bed Test of Wood Preservatives" was presented by the author, Mr. Cloyd M. Chapman.

The report of Committee D-13 on Standard Tests and Specifications for Textile Materials was presented by Mr. W. D. Hartshorne, Chairman.

On motion, the proposed Tentative Tests for Automobile Tire Fabrics were amended as follows, and accepted for publication among the Tentative Standards in the Year-Book:

(*a*) Insert the following new Section 10:

"IV. LENGTH.

"10. The length of a roll shall be determined by running the cloth over a measuring drum of known circumference, from which the yardage is registered by a dial or counter driven by a chain or other positive and non-slip mechanism. Just enough uniform tension[1] is to be used on the cloth to keep it running flat and true."

(*b*) Change Section 10 to Section 11, and insert the following footnote to the last word, "count," in that section:

[1] It has been suggested that a uniform tension of 2.5 times the weight of five running yards of the fabric will be sufficient to keep the fabric flat and preserve a proper relation for comparison of different fabrics. Invitation is extended to report to the committee the results of such tests upon different fabrics."

"A 10-in. steel "count scale" similar to an engineer's triangular scale, graduated with teeth 1 in. apart on one edge and to the specifications of the cloth on the others,—for example, 23 teeth per inch on the second and 23 teeth per inch with each inch indicated on the third edge, as shown in Fig. 2,—will be found convenient, rapid, and accurate for making this measurement when used in the manner of a machinist's thread gage. The chairman will furnish any information desired regarding this count scale."

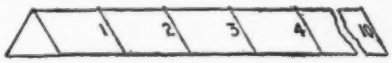


FIG. 2.

The report of Committee D-8 on Waterproofing Materials was presented by Mr. W. A. Aiken, Chairman.

The Chair then declared the meeting adjourned *sine die.*

AMERICAN SOCIETY FOR TESTING MATERIALS.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROCEEDINGS.

The Society is not responsible, as a body, for the statements and opinions advanced in its publications.

OUR RAIL SPECIFICATIONS.

ANNUAL ADDRESS BY THE PRESIDENT, A. W. GIBBS.

It is with much diffidence that I ask you to-night to consider the effect of our Society's specifications in the working out of one of the great transportation problems in which we are all vitally interested.

Please consider it in its broader bearings, for while the solution of the problem may first affect those who have invested their savings in companies producing transportation, in the end we, as a nation, cannot get transportation for less than it costs. We must pay the bill, whether the sellers of this transportation be individuals or the people at large. In speaking of the owners, let us forget for a time whether they be individuals, corporations, or the public.

How shall this transportation be manufactured and sold at a price that will make investment in this field desirable?

The public certainly objects to paying more for it, and practically controls prices by legislative enactment. In addition to the ever-growing burdens of taxation, are others, such as elimination of grade crossings, substitution of steel in place of wooden passenger equipment, terminals, and the like, which produce little return in revenue. By no means least, those who labor are always asking more pay for the same or less service, and there is no prospect that any servant will remain satisfied.

The total of all these rising costs threatens to wipe out the margin of profit, and the owners are forced to find some method of providing revenue, not attended by corresponding increase in expense.

In this country the answer has been operation by larger units. Tersely stated, it means heavier loads and more of them.

This is a path which, once entered upon, admits of no turning back. It leads to many difficulties, which must be faced and overcome. Had the railroads to revert to the old methods, using the type of equipment standard twenty years ago, it is improbable that they could exist under modern conditions and burdens. The sheriff would have them!

It leads directly to the Rail Problem, for which, at the risk of going beyond the immediate scope of our Society, I ask your consideration.

It is true that in this country we are using heavier concentrated loads than are carried elsewhere. Much has been written to show the relative increases of the weights of rail and of loads carried, and conclusions have been drawn that one or the other has unduly increased. The flaw in this argument is that the contemporaneous comparisons have been of the heaviest rail and the heaviest load, forgetting the fact that the heaviest loads are few in number, and that the prevailing rail section over which they run is not the heaviest.

Definite conclusions as to the performance of different lots of rail are difficult to draw. Statistics of actual service worthy of confidence are still young and far from complete. The labor of following the location and service of different trial orders is very great, and many of the data are unavailable for comparison because the conditions of service are not directly the same. In addition, we must remember that it is the exceptional man who is fitted for experimental work.

The variables in the conditions of service are very great and very perplexing. The climatic conditions are directly reflected in the monthly record of failures of all kinds, and a spell of unusually severe winter weather is immediately marked by a sudden increase in the number of failures, one most potent reason being the rigidity and unevenness of the rail support. On the other hand, a succession of mild winters may show such

a comparative immunity from failures as to delude us into the belief that at last we are making definite progress.

The number of rails which fail annually, as compared with the total number in service, is very small when reduced to percentages. In many materials it could be ignored as purely an economic loss, and not very large at that. The enormous preponderance of those laid are removed because they are worn out. It is because the rail is part of a chain that its occasional failure assumes such importance.

With the above points in mind, it must be said that the available data do not show that progress in performance which we have a right to expect. It is true that certain classes of failures have greatly diminished, but these are directly traceable to improvements in design rather than in quality, and, taking the records altogether, the progress is very disappointing.

That the real answer to this great problem has not been reached is proved by the continued unrest in our specifications, and by the everlasting changes in sections.

What answer can we make?

First, as users, we can and should lessen as far as possible unnecessary punishment of the rail by improvements in the mechanical design and maintenance of our equipment.

We can be expected to improve our structure under the rail as our loads increase, and this change is in progress. It is but fair to say that bad conditions, both as to equipment and track structure, have contributed to rail failures. It is probable that this condition has always existed, and in times of business depression maintenance standards may have been lowered, but, altogether, the conditions of use are not worse. It is not probable that perfect track will ever be constructed or maintained, as the means for doing this are necessarily too crude.

That the large number of failures of rails has attracted no more attention is because of the thoroughness of the track inspection. In the very great majority of cases the rails are removed before any serious results ensue, but we must not take too much comfort from this fact, for each case offers the possibility of most serious consequences, and this is fully recognized.

Against these unsatisfactory conditions we have several possible solutions: Better steel in the sense of more uniform

steel; better steel in connection with more rational sections; materially heavier sections; or retrogression in loads and speeds.

To date, a combination of the first and second has been chosen. There has been a very general change to open-hearth steel, at an increased cost.

Committees of this and sister societies have worked almost continuously on the subject of specifications. To-day, after our fourth revision in a period of eight years, our specification is almost identical with that of the American Railway Engineering Association, but the seemingly small differences are really very important. Both specifications are identical in chemical requirements; both provide that the chemistry furnished by the producer shall be that of the drillings from the ladle test ingot; but both ignore the fact that the chemistry of the actual rails, at least of part of them, is apt to differ widely from the ladle analysis. In the case of the open-hearth specifications there is at least the merit of an analysis for each heat. In the case of the Bessemer rail, the chemistry other than carbon is averaged from two complete analyses per twenty-four hours, to determine the quality. It is difficult to see how a specification could be made more absurd, and yet this clause in one form or another has been and still is part of many specifications, and it did not originate with our committee.

Neither the American Society for Testing Materials or the American Railway Engineering Association specification really protects the buyer as to chemistry. Neither puts any limit on the amount of segregation permitted, and it is well known that this ranges over wider limits than would be permitted in the ladle analysis.

In investigating the causes of the failures of individual rails, many analyses have shown such startling discrepancies between the composition of the failed rail and the analysis purporting to represent the heat, that it was difficult to believe that they could represent the same material. Either the ladle analysis is an unreliable index of the quality of the material in the rail, or there is a great need for chemical reform. We know by experience that when put to it, the chemists of the producers and the consumers can tally within very reasonable limits. This is a serious matter for the consumer. In several of the railroad wrecks

due to a failed rail, the Government representatives analyzed the rail and discovered that the composition did not at all agree with that called for in the specification, and severely scored the road for not enforcing its own specifications. How far the difference between chemists is due to difference in methods I do not know, but possibly the methods by which the chemistry is determined may have to be agreed upon and made a part of our specifications. Dr. C. B. Dudley, who did much work on standardizing methods of chemical analysis, would in his specifications not only state the composition required, but also the methods by which the determination was to be made.

From the physical standpoint both specifications are defective, as both contain the provision that if the test piece meets the requirements, the material will be accepted; but in the event of the failure of the first test piece, two more tests are made, and if both pass, the material is accepted. We hold that this is a pernicious practice, in that the consumer has positive proof that some of the accepted material does not meet the requirements. How this clause ever crept into the specifications, we do not know. We do know that it is nothing new. If meeting a single test means acceptance of a definite quantity of material, failure to do so should mean a definite rejection, and in a number of our other specifications this is the case.

Our own American Society for Testing Materials specification includes all the machinery for detecting physically unsound material by nicking and breaking, and then provides that the rails represented by these unsound test pieces shall be accepted as "Special" rails. Presumably they are to be used in some unimportant location. This is another very bad practice. It is not always possible to find unimportant places. Designating marks in the way of paint or punch marks become illegible in time. The only sure way to keep such material out of important service is not to ship it from the mill. The total additional cost per ton for eliminating both of these objectionable physical clauses is quite well known and is not large. In some specifications both are cut out, but we hold that a buyer should not have to pay an additional price to avoid taking material which does not fairly meet the prescribed tests.

Summed up, the rail specification of our Society does not

put a proper premium on the selection of the better part of the ingot for one of the most exacting services for which steel is used. Where our specification differs from that of the American Railway Engineering Association it is not so good.

Our committee is composed of capable men. Among them are some of the ablest metallurgists in the country, and we should look to them for that constructive work which would make our specification beyond criticism. The purpose of our Society is to make specifications and have them used. If year after year we retain provisions that lessen the incentive to improve the product, we cannot wonder if other specifications are preferred.

If we consider all the steps in our rail industry, we find very few improvements in methods other than those which lend themselves to increased output or reduced cost. There are some notable exceptions to this, three in particular: namely, the electric furnace, for producing better steel; the sinkhead process for casting ingots, for producing better ingots; and the deseaming process, for producing better rails, by mechanically removing some surface defects which would later develop into seams. All of these processes are represented by rails actually in track under observation, but it is yet too soon to justify an opinion as to their value, nor have any of these methods been generally adopted.

In this connection, it may be mentioned that, in addition to the sinkhead-process steel rail made in this country by American methods, we have, also, a small supply of ingots made in Sheffield by the Hadfield patented process, which will shortly be rolled into rail and put in service.

Heat treatment, although not yet on a commercial scale, has been attempted, and such rails are actually in service under severe conditions. So far as non-service tests go, the results are promising.

It is to be hoped that some of the large-scale experiments now in progress will show what is to be looked for from a more uniform product. One of these includes the requirement that the chemistry as determined by the chemists of the purchaser, shall be from the rail, instead of from the ladle test ingot, and the segregation must be within reasonable limits. This experiment will, at least, give a quantity of fairly uniform material,

so far as any practical method of representative testing will insure it. Let us hope that it will give some definite light as to how far we should go toward more uniform material.

Should it develop from the test of service that by means of more uniform steel, namely, by analysis from the finished rail, with limits of permissible segregation, we eliminate enough of our serious failures to make it worth while, we will have to face the question of how such provisions shall be carried out. It is certain that few railroad organizations have the chemists to make the determinations on the spot, so that by the time the rail is ready for shipment the makers will have advice from the chemists that the steel is acceptable. It is very desirable that this complication be avoided, but, if uniform steel proves to be the remedy, the consumers must know that they are getting it.

Aside from these, and some experiments on too small a scale to deserve special notice, the rail situation remains very much as it was seven or eight years ago. Any deviation from the beaten path is immediately met by an increase in the price asked, the reasonableness of which the purchaser has no means of determining. In at least one case of which I have knowledge, the actual expense of every kind, so far as it could be ascertained, due to rail breakage on a certain system was less than one-fifth of the annual increase in the cost of rail due to the introduction of a proposed new specification designed to secure the quality of rail desired. The year taken was not an abnormal one in any way. One serious wreck would, however, entirely have changed this showing. It requires a lot of courage and a strong sense of duty to justify such an expenditure when the direct return is problematical.

Heavier Rail.—There are many who believe that we cannot hope for relief by the use of more uniform steel. They make the point that, if this is the solution, it can be obtained by a discard larger than the ordinary. They cite the records of the carriers to show that the failures, especially the breakages, are fairly well distributed throughout the ingot, so that no practicable discard would eliminate the trouble. They also call attention to the many examinations of broken rail which reveal no defect that we can recognize as such. From these conditions they argue that the only remedy is to use more steel—that is,

heavier sections—without any change in the specifications as to quality. Possibly this is correct, but we would call attention to the fact that post mortems on rail sometimes give negative results, because we have not before us all the related evidence. The rail may have been damaged by unfair usage, of which there is no evidence. If due to defective support, the evidence is lost when the track is repaired. . Damage from defective wheels, etc., leaves no permanent mark. There is a growing belief that the straightening press, by straining the material beyond the elastic limit, is responsible for many otherwise unexplainable failures, and it would also explain why rails from the lower part of the ingot figure so prominently in the breakage record.

As to the quality, we cannot ignore the fact of the difference between rails from different mills. There have been some notoriously bad rollings, as shown by the records of various roads, and these mills have subsequently turned out an excellent product. If all of the rail was as good as the best, we would have very little room for complaint.

The present line of progress includes a general increase in the weight of sections throughout the country. The 100-lb. mark, or that neighborhood, seems to be one of the halting spots, but some sections go considerably beyond this figure. A careful study has been made of the sections, and the new ones, especially of the heavier weights, are believed to be better adapted to secure good mill results, as well as better performance in the track.

Personally, I believe that the time has arrived for a considerable increase in the weight of sections, but I am not so certain that a change of quality is required at the same time. One reason that appeals is the presence within recent years of that class of failures known as "transverse fissures." So far, there seems to be no satisfactory explanation. It seems surprising, if this class of breakage develops in the rail, that it should not also do so in the tire, which is subject to the same intensity of pressure. The tire, however, has an immensely greater section than the head of the rail, and it is not until from one-third to one-half of the original area has been removed by wear and turning that it becomes necessary to remove the

tire from service. If the mere fact of the relatively large area or section of the tire contributes immunity from this class of failure, it is fair to assume that somewhat the same result could be looked for in the case of the rail head.

Certain practices, such as the present system of straightening, have long called for improvement. Nearly all rail passes through the gagging press. The rail specifications are possibly too exacting in requiring that all rails shall be "smooth, straight in line and surface, and without any twists, waves, or kinks." It is a question whether this is not asking too much for the good of the rail and whether it would not be well to make the greatest possible tolerance in the way of accepting rail with such variations from straightness as can be reasonably eliminated in laying.

Mill Methods.—In the search for a remedy for our troubles, some have proposed to improve the product by more or less radical changes in the mill practice. It must be remembered, however, that a modern steel mill, like the railroad, can only exist by being operated on a large scale. It is designed in advance with a view to a certain sequence of operations, and if proper provision has been made for each, smooth operation follows. The mill, however, is only balanced when it performs these operations in the prearranged order, and to make a radical change—as, for instance, slow rolling, cold rolling, more passes, or one of the many other innovations suggested, may seriously unbalance the whole operation. It is not to be expected that a mill will be willing to make changes in its practice until after experimental work has demonstrated that the proposed practice is practicable and valuable. This does not mean that the mere assertion that the proposed changes are impracticable absolves us from doing anything further; on the contrary, the steel mills should be willing to go as far as possible in the direction of proving or disproving these theories.

Many of the questions could be settled by a small mill, in connection with a large one, at which experiments could be made without affecting the regular operations of the works. It may be feasible to provide such a mill by some form of cooperation, through which the expenses and the benefits may be distributed among subscribing companies.

In conclusion, I must repeat that the rail situation, as we see it, is disappointing. To add to the complexity of the situation, the Government, through some of its bureaus, is taking a hand and investigating every serious failure, apportioning blame and suggesting remedies. This will probably increase rather than diminish, and may some day be very awkward for the producer as well as for the user.

The function of our Society is to prescribe specifications and tests, which, if enforced, will prevent improper material from getting into service. This calls for constructive work in committee; but it has been accomplished with other products, why not with rail?

ANNUAL REPORT OF THE EXECUTIVE COMMITTEE.

Publications.—The regular publications issued during the past year exceed in volume by 149 pages those of the preceding year, which were in turn largely in excess of those for any earlier year, the comparison for the past two years being as follows:

	1913–14. PAGES.	1914–15. PAGES.
Proceedings	1141	1162
Year-Book	401	500
Membership Pamphlet	190	219
Total	1732	1881

The regular publications in 1913–14, which amounted to 1732 pages, were increased by 158 pages by the publication and gratuitous distribution among the members of the Society of the Index of Volumes I–XII, making the total for that year 1890 pages.

The 1914 Year-Book contains 6 new and 21 revised standards as compared with the 1913 Year-Book, or a total of 70 standards. In addition to the foregoing, 928 pages of the Proceedings were preprinted (as against 699 pages for the previous year), of which 668 pages (as against 461 pages for the previous year) were distributed among the membership at large in advance of the last annual meeting. Only one committee found it impracticable to have its report available sufficiently far in advance of the last annual meeting to admit of preprinting.

There have also been issued since the last annual meeting eleven circulars to members aggregating 44 pages.

The effect of the policy, inaugurated on an extensive scale for the first time two years ago, of preprinting committee reports and papers and distributing these among the membership at large in advance of their presentation at the annual meeting, as shown by the increased volume of discussion, may be judged

from the following table, in which no data are given for the year 1912 inasmuch as the Proceedings for that year were limited exclusively to committee reports in order not to weaken the contributions from American sources to the International Congress, held that year in New York City.

Year.	Discussion (pages).			Proceedings, Total Pages.	Ratio of Discussion to Total Pages, per cent.
	Verbal.	By Letter.	Total.		
1911	94	6	100	890	11.2
1913	121	68	189	1141	16.6
1914	153	62	215	1162	18.5

The increasing deficit in the treasury, which will be analyzed in detail hereafter in this report, is chiefly attributable to the increasing volume of publications, the improved standards observed in connection with illustrated matter, and the cost of preprints, the expenditure for the last item, including the cost of distribution, amounting last year to $2039.92.

The innovation, inaugurated last year, of publishing a summary of each paper both in the preprints and in the Proceedings has been favorably received.

In consequence of the increasing deficit in the treasury, and also with a view of making better provision for discussion, Committee E-6 on Papers and Publications was charged to reduce the scope of the program for this meeting, in so far as that might be found feasible with due regard to the best interests of the Society. Notwithstanding efforts in that direction, within the limits stated, the material in view for this meeting aggregates 968 pages, as compared with 939 last year.

The increasing use of the Standard Specifications of the Society in Federal, State and Municipal circles, apart from their extensive adoption in ordinary commercial channels, is significant of the confidence placed in the work of the Society and serves to emphasize the reciprocal obligation upon the Society to justify that confidence in connection with everything to which its name is attached. It may not be known to the membership

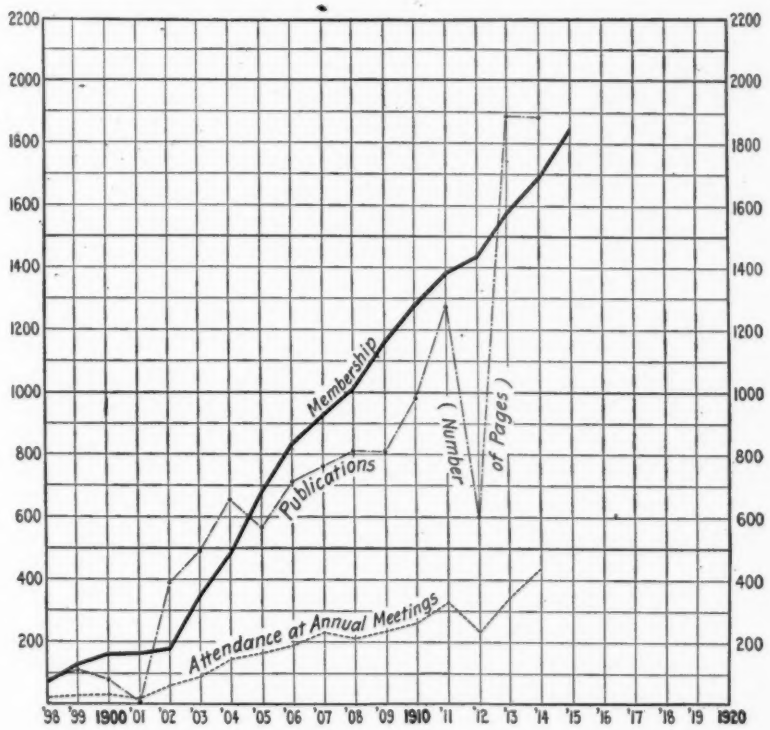
at large, for example, that the purchases for the Panama Canal have been made largely under its standards, 27 of the Standard Specifications of the Society being now in use by the purchasing department of the Canal; also that the United States postal cars are purchased subject to the A. S. T. M. Standard Specifications. Again, nine of the Standard Specifications have been adopted—in some cases with slight modifications—in conection with the Boiler Code recently prepared by a committee of the American Society of Mechanical Engineers, which is expected to be adopted in many States by legal enactment. Similarly, in the current revision of the Building Code of the City of New York, seven Standards of the Society are referred to in some such form as the following: "Except as may be otherwise prescribed by the rules of the Superintendent of Buildings ..... shall conform to the Standard Specifications of the American Society for Testing Materials for ....."

Membership.—The membership at the last annual meeting was 1687. Since then 298 applications for membership have been approved, as compared with 265 during the previous year. The losses by death number 7, namely:

John Birkinbine.....May 14, 1915
J. Galbraith.....July 22, 1914
A. F. Gerstell.....October 16, 1914
R. W. Mahon.....March 8, 1915
E. D. Meier.....December 15, 1914
J. M. Sherrerd.....April 15, 1915
A. P. Trautwein.....August 4, 1914.

The number of resignations is 75, and 61 members have been dropped for non-payment of dues, the former number being 11 in excess and the latter 18 below the corresponding numbers for the previous year. The total losses for the year from all causes thus number 143, and the net increase in membership for the year is 155, as against 113 for the previous year, and as compared with an average net annual increase of 105 for the preceding five years. In view of the past and present serious industrial depression, this record bears strong evidence of the value in which membership in the Society is held. The total membership in the Society is now 1842.

It is interesting to record that of the 298 applications for membership approved during the year, 97 were received during the last six months in 1914, and 201 during the first six months



NOTE.—The marked drop in publications and attendance at the annual meeting for the year 1912 is due to the fact that the Sixth Congress of the International Association for Testing Materials was held in New York in September, 1912, and that the activities of the American Society for that year were accordingly restricted to committee reports and administrative business.

of 1915. In a general way this comparative showing is characteristic of the experiences for other years, but the increased returns this year are attributable partly to the recently inaugu-

rated movement towards increasing the membership. In this connection the Executive Committee desires to renew its appeal to members to interest themselves actively and individually in bringing the value of membership in the Society to the notice of individuals, corporations and firms whose connection with the Society promises to be mutually advantageous.

Technical Committees.—The marked activity of the technical committees is evidenced partly by the many valuable reports that have been prepared for presentation at this meeting. Much work has also been done by other committees who are not yet prepared to report results to the Society.

Committee A-7 on the Tempering and Testing of Steel Springs has been discontinued as an independent committee and merged with Sub-Committee IV on Spring Steel and Steel Springs, of Committee A-1 on Standard Specifications for Steel.

The designation of Committee E-5 on Regulations Governing the Form but not the Substance of Specifications has been changed, on its own recommendation, to Committee E-5 on Technical Committees, with the understanding that the following explanatory clause defining the duties of the committee shall follow reference to its title: "The duties of this committee are the formulation of (*a*) Regulations Governing Technical Committees, (*b*) Regulations Governing the Form but not the Substance of Standards, and (*c*) the Classification of Standards."

The personnel of Committee D-8 on Waterproofing Materials has been materially enlarged during the year with a view of making it more thoroughly representative of the important interests involved.

The following four new committees have been created during the year:

Committee C-10 on Standard Specifications for Hollow Building Tile, under the temporary chairmanship of Mr. Edward Orton, Jr.

Committee C-11 on Standard Specifications for Gypsum and Gypsum Products, under the chairmanship of Mr. Rudolph J. Wig.

Committee D-13 on Standards Tests and Specifications for Textile Materials, under the chairmanship of Mr. W. D. Hartshorne.

Committee E-3 on Revision of Pipe Threads, under the chairmanship of Mr. H. V. Wille.

The total number of technical committees is now 39.

The financial condition of the Society unfortunately not admitting of substantial support for the conduct of investigations by its technical committees, special funds for the prosecution of their individual work were raised by Committee A-5 on Corrosion of Iron and Steel to the amount of $2500, and by Committee C-9 on Standard Tests of Concrete and Concrete Aggregates to the amount of $900. Committee C-10 on Standard Specifications for Hollow Building Tile has received pledges to the amount of $600.

The Regulations Governing Technical Committees provide that any recommendations affecting specifications or other standards must be sent in printed form to every member of the Society not less than four weeks before the annual meeting at which these recommendations are to be presented. This regulation has been strictly observed in connection with the matter listed below, with the exception of the items under the title "Proposed New Tentative Standards" distinguished by an (*), for which this was not feasible.

I. PROPOSED NEW STANDARDS.

Recommended by Committee A-1 on Steel:

For Heat-Treated High-Carbon-Steel Splice Bars.
For Heat-Treated Carbon-Steel Track Bolts.
For Heat-Treated Alloy-Steel Track Bolts.
For Lap-Welded and Seamless Boiler Tubes for Stationary Service.
For Welded Steel and Wrought-Iron Pipe.
Methods for Chemical Analysis of Alloy Steels.

Recommended by Committee A-2 on Wrought Iron:

For Iron and Steel Chain.

Recommended by Committee A-3 on Cast Iron:

Methods for Sampling and Analysis of Pig and Cast Iron (for Export).

Recommended by Committee A-8 on Cold-Drawn Steel:

For Cold-Drawn Steel: Open-hearth Automatic Screw Stock.

Recommended by Committee B-2 on Non-Ferrous Metals:

For the Alloy: Copper, 88 per cent; Tin, 10 per cent; Zinc, 2 per cent.

Recommended by Committee C-3 on Brick:

For Paving Brick.

Recommended by Committee C-4 on Sewer Pipe:

Definitions of Terms Relating to Sewer Pipe.

Recommended by Committee C-7 on Lime:

For Quicklime.
For Hydrated Lime.

Recommended by Committee D-1 on Preservative Coatings:

For Purity of Raw Chinese Wood Oil.
For Purity of Boiled Linseed Oil from North American Seed.
Definitions of Terms Used in Paint Specifications.
For Turpentine.

Recommended by Committee D-2 on Lubricants:

Tests for Lubricants.

Recommended by Committee D-4 on Road Materials:

Definitions of Terms Relating to Materials Used in Roads and Pavements.

Recommended by Committee D-11 on Rubber Products:

For $2\frac{5}{8}$-in. Cotton Rubber-Lined Fire Hose for Private Department Use.
Methods for Testing of Cotton Rubber-Lined Hose.

II. PROPOSED NEW TENTATIVE STANDARDS.

Recommended by Committee A-1 on Steel:

For Carbon-Steel Bars for Vehicle and Automobile Springs.
For Silico-Manganese-Steel Bars for Automobile and Railway Springs.

Recommended by Committee A-1 (Continued):

For Chrome-Vanadium-Steel Bars for Automobile and Railway Springs.
For Helical and Elliptical Springs for Railways.
For Alloy-Steel Forgings.
For Quenched-and-Tempered Alloy-Steel Axles, Shafts and other Forgings for Locomotives and Cars.

Recommended by Committee B-1 on Copper Wire:

For Bare Concentric-Lay Copper Cable: Hard, Medium-Hard, or Soft.
For High-Strength Bronze Trolley Wire, Round and Grooved: 40 and 65-per-cent Conductivity.

Recommended by Committee C-4 on Sewer Pipe:

Recommended Practice for Laying of Sewer Pipe.

Recommended by Committee D-1 on Preservative Coatings:

*Methods for Routine Analysis of White Pigments.
Test for Distillation of Paint Thinners other than Turpentine.
Test for Moisture in Bleached Shellac.

Recommended by Committee D-4 on Road Materials:

Definitions of Terms Relating to Non-Bituminous Road Materials.

Recommended by Committee D-5 on Coal:

Method for Sampling of Coal.

Recommended by Committee D-6 on Coke:

For Foundry Coke.

Recommended by Committee D-7 on Timber:

For Southern Yellow-Pine Timber to be Creosoted.
For Southern Yellow-Pine Piles and Poles to be Creosoted.
Methods for Sampling and Analysis of Creosote Oil.

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*It was not feasible to distribute these tentative standards four weeks in advance of the annual meeting.

Recommended by Committee D-13 on Textile Materials:

Tests for Automobile Tire Fabrics.

Recommended by Committee E-4 on Methods of Sampling and Analysis of Coal:

*Methods for Sampling and Analysis of Coal.

III. PROPOSED REVISION OF STANDARDS.

Recommended by Committee A-1 on Steel:

For Structural Steel for Bridges (Serial Designation: A 7–14).

For Automobile Carbon and Alloy Steels (Serial Designation: A 29–14).

Recommended by Committee A-3 on Cast Iron:

For Malleable Iron Castings (Serial Designation: A 47–04).

Recommended by Committee B-1 on Copper Wire:

For Hard-Drawn Copper Wire (Serial Designation: B 1–13).

For Medium Hard-Drawn Copper Wire (Serial Designation: B 2–13).

For Soft or Annealed Copper Wire (Serial Designation: B 3–13).

Recommended by Committee D-1 on Preservative Coatings:

For Purity of Raw Linseed Oil from North American Seed (Serial Designation: D 1–13).

Recommended by Committee D-7 on Timber:

Classification of Structural Timber (Serial Designation: D 9–07).

For Yellow-Pine Bridge and Trestle Timbers (Serial Designation: D 10–10).

Recommended by Committee E-1 on Methods of Testing:

Methods of Testing (Serial Designation: E 1–11).

* It was not feasible to distribute these tentative standards four weeks in advance of the annual meeting.

An extended but indecisive discussion at the last annual meeting as to the desirability of abrogating the vote by letter ballot of the membership at large, as the final step in the prescribed procedure for the adoption of Standards, led the Executive Committee to institute a straw vote on this subject with a view of ascertaining the sentiment of the membership at large. This straw vote resulted in 281 affirmative votes and 115 negative votes on the question of adherence to the present policy. The Executive Committee has accordingly decided to recommend no change in that policy.

During the year many changes have been made in the Regulations Governing Technical Committees by joint action of Committee E-5 and the Executive Committee. These changes appear in detail in the report of Committee E-5 and are therefore not repeated here.

FINANCES.

The following is an excerpt from the last annual report of the Executive Committee in relation to finances:

> "In the past experience of the Society it has never been possible to cover the cost of the publications for a given year from the receipts for that year. That is to say, there has always been a deficit on January 1, the beginning of a new fiscal year, of which the Secretary-Treasurer's annual reports (for the twelve-month periods ending June 1) have given no direct evidence. It is estimated that this year it will be possible to defray the current expenses for the year out of the receipts, and it is hoped that a surplus will also be available to partially offset the expenditures out of the receipts for the current fiscal year which have been applied to the payment of obligations incurred during the previous year."

These deficits have amounted to the sums shown in the last column of the following table at the close (December 31) of the last six fiscal years. The entries under "unpaid bills" cover all obligations incurred in connection with the publications for

the corresponding year, irrespective of whether the bills for the same had or had not been rendered prior to December 31. In some instances the Proceedings did not appear till January or February, but their cost in such cases should fairly be regarded as a lien on the receipts for the previous year, as has been done in this table.

CONDITIONS AT CLOSE OF FISCAL YEARS 1909–1914, INCLUSIVE.

Fiscal Year.	Cash Balance.	Unpaid Bills.			Accounts Receivable.*	Deficit.
		Received.	Not Rendered.	Total.		
1909	$1 250.58	$1 375.00	$3 563.20	$4 938.20	$425.75	$3 261.87
1910	450.84	1 000.00	3 014.89	4 014.89	347.20	3 216.85
1911	2 875.66	.....	4 894.81	4 894.81	336.80	1 682.35
1912	1 216.47	.....	2 500.00	2 500.00	385.79	897.74
1913	1 139.87	4 621.37	771.64	5 393.01	662.19	3 590.95
1914	43.57	6 199.05	222.22	6 421.27	1 044.74	5 332.96

*Back dues not included. The amounts realized from back dues are relatively small, the sum this year, for example, being $245.

JOHN HEINS & CO.
PUBLIC ACCOUNTANTS AND AUDITORS
PHILADELPHIA, June 4, 1915.

MR. EDGAR MARBURG, *Secretary-Treasurer*,
American Society for Testing Materials,
Philadelphia, Pa.

Dear Sir:

We hereby certify that the above statement showing the financial condition of the American Society for Testing Materials at the close of the several fiscal years therein stated has been audited and examined by us and is correct.

Yours respectfully,

(Signed) JOHN HEINS & CO.

It is seen from the above that the deficit has increased at the average rate of about $2200 per annum for the past two years.

Inventory of Publications.—In the foregoing no account has been taken of the assets of the Society in the form of publications in stock, the inventory of these on May 13, 1915, being as follows:

VOLUME.	COPIES.	VOLUME.	COPIES.	VOLUME.	COPIES.
I	54	VI	699	XI	442
II	158	VII	438	XII	195
III	54	VIII	449	XIII	513
IV	180	IX	557	XIV, Part I	628
V	285	X	494	XIV, Part II	633

Total stock of Proceedings, 5779 volumes.

The present stock of publications also contains 787 copies of the Index of Vols. I–XII of the Proceedings, and 401 copies of the Reports of Committee D-1 on Preservative Coatings for Structural Materials for the years 1903–1914, as well as limited editions of separate reprints of the 70 Standards adopted by the Society. According to the policy of not providing for a surplus stock of the Year-Books above the estimated sales for the year, only a few copies of the older Year-Books remain on hand and the editions are in part wholly exhausted.

The original cost of the publications in stock is approximately as follows:

Proceedings	5779	copies at	$1.50	$8 668.50
Index	787	" "	0.50	393.50
Committee D-1	401	" "	1.75	701.75
Total cost				$9 763.75

The market value of the publications, at full list prices, is as follows:

Proceedings (paper binding)	4 180	copies at	$5.00	$20 900.00
Proceedings (cloth ")	1 057	" "	5.50	5 813.50
Proceedings (leather ")	542	" "	6.00	3 252.00
Total Proceedings	5 779	copies		$29 965.50
Index of Vols. I–XII	787	copies at	$1.50	1 180.50
Reports of Committee D-1	401	" "	3.50	1 403.50
Total				$32 549.50

The sales of the Proceedings for the fiscal year ending December 31, 1914, amounted to 305 volumes aggregating $1290.50, which include 39 copies of Vol. XIII, 58 copies of

Vol. XIV, Part I, and 56 copies of Vol. XIV, Part II, at a joint aggregate sum of $663.90.

Although the actual cash value of the publications in stock cannot be definitely fixed, it is obviously in excess of the deficit of $5332.96 at the beginning of the fiscal year, so that there can be no doubt as to the technical solvency of the Society. A plan by which entire sets of certain series of the back volumes would be offered at special prices to the members of the Society and to libraries, and under proper restrictions to others, as well as the question of advertising such a sale in the technical press, will receive early consideration by the Executive Committee.

Recent Operations and Their Cost.—It is estimated that the cost of operations for the last fiscal year amounted to $10.79 per member, thus representing a loss of $0.79 on each Member and $5.79 on each Junior Member.

The annual dues were increased from $5 to $10 for members on August 1, 1910, with the announced understanding

> (*a*) That a Year-Book, bound in cloth, shall be furnished annually to members, containing in addition to the contents of the present annual pamphlet, all standard specifications in revised up-to-date form. There are at present 24 standard specifications aggregating 121 pages, which, with the other matter referred to, will make a volume of about 275 pages.
>
> (*b*) That the annual volume of the Proceedings shall hereafter be supplied in cloth binding to members without extra charge for binding, and that the additional charge of half-morocco binding shall be 50 cents instead of $1.
>
> (*c*) That a new class of Junior membership shall be created, consisting of persons less than thirty years of age, for whom the annual dues, shall be $5 and who shall enjoy all the privileges of Members.

The policy of issuing on an extensive scale preprints of matter to be presented at annual meetings was not inaugurated until 1913, but prior to that year a net expense above sales of $429.53 was incurred in connection with the Dudley Memorial Volume, and a subscription of $5000 was made towards the publications

of the New York Congress of the International Association held in 1912, with the understanding that every member of the American Society should receive, without charge, a copy of the Congress Proceedings; the publications of the American Society having been restricted for that year to committee reports and the Year-Book, which were issued under a single cover.

In 1913 every member of the Society received a cloth-bound copy of the Index of Vols. I–XII of the Proceedings without charge and at a net expense of $1312.09 above sales, offset by a present stock of 787 copies.

In the same year the Society issued an edition of 1000 copies of a volume containing reprints of the Reports of Committee D-1 on Preservative Coatings for Structural Materials for the years 1903–1913, of which 538 copies were sold prior to 1915. To the remaining copies, which had been kept unbound for that purpose, there was added the reprint of the 1914 report of that committee, the sales of this enlarged volume amounting to only 21 copies. The total cost of this publication is $1779.45 and the sales to date aggregate $1234.31, so that the present deficit is $545.14, which is offset by 401 unsold copies.

In addition to the aggregate net cost of $2286.76 of the above three special publications, the rapid increase of the scope of the regular activities of the Society and its cost may be partly judged from the following data:

1. The first Year-Book, issued in 1910, which also contained the membership list of the Society, consisted of a volume of 308 pages. The 1914 Year-Book (pp. 500) and the 1914 Membership Pamphlet (219 pp.), which latter has been issued separately since 1913, aggregate 719 pages, as against 308 pages four years earlier.

2. The increased volume of the publications in general which have risen from 809 pages in 1909 (the last year for which the dues were $5) to 1890 in 1913, and 1881 in 1914.

3. The heavy expense incident to the publication and distribution of preprints on an extensive scale, the cost of this item in 1914 amounting to $2039.92.

4. The policy inaugurated in 1913 by which all line drawings and diagrams in the Proceedings are prepared by high-grade

experts at a considerable increase upon the cost of similar work under the lower standards observed in earlier years.

5. The greatly increased scale of operations during the past four years has led to a substantial increase in salary payments, these amounting to $2942.94 for the fiscal year 1910 and $5709.10 for 1914. To these sums should be added $417.99 and $946.36, respectively, on account of special clerical services charged against the cost of publications.

In addition to the increasing expenses from the above and other causes, there have been substantial losses in revenue through:

1. The cancellation in 1910 of the previously mentioned charges for binding. Last year this item would have amounted to $1.50 per member (except for those who have ordered paper binding) since, in addition to the Year-Book, the Proceedings were issued in two volumes.

2. The creation of a class of Junior Members in 1910 coincident with the increase of dues to members, this class having been carried last year at a loss of about $1000.

Possible Sources of Increased Revenue.—The following measures, through proposed amendments of the by-laws, have been recommended elsewhere in this report:

1. The reduction of the age limit for Junior Members from 30 to 25 years.

2. The requirement of initiation fees of $10 for Members and $5 for Junior Members, the latter being subject to a supplementary fee of $5 on their transfer to the grade of Member.

The adoption of these two measures would result in an estimated gain of about $2500 per annum in addition to the normal annual increase of revenue which may be estimated at $1000.

Furthermore, at the beginning of the year the Executive Committee instructed Committee E-6 on Papers and Publications to curtail the number of papers for the next annual meeting by conducting a less vigorous campaign than ordinarily in solicitation of papers, and by exercising a more discriminating choice among the papers offered.

It was thought that the above three measures, together with an appeal to the membership at large to interest themselves

actively towards increasing the membership of the Society might jointly serve to meet the financial situation adequately and to render possible the gradual extinguishment of the deficit of $5332.96 in the treasury at the beginning of the fiscal year. It has proved impracticable, however, without the adoption of arbitrary rulings, to curtail the program materially, and the results of the movement towards increasing the membership have thus far not met expectations.

The following are among the possible means, in addition to those above recommended, by which the revenues of the Society may be increased:

3. The restoration of the former extra charges for binding, to be applied both to the Year-Book and the Proceedings, the yield from which may be conservatively estimated at from $1200 to $1800 per annum, according to whether the Proceedings are issued in one or two volumes.

4. A policy by which members would obtain the Year-Book only by the payment of an extra charge of, say, $2.50, which would probably yield an additional annual sum of $2500.

5. A policy by which the dues of corporations and firms would be, say, $5 in excess of those of individual members. The number of memberships thus affected being at present 381, the corresponding annual increase of revenue would be about $1900.

6. The solicitation of subscriptions towards a publication and research fund, as in the earliest days of the Society.

7. A general increase of dues of $2.50 per annum for Members and $1.00 for Junior Members, which would yield an annual increase of revenue of $4250 on the basis of the present membership.

Possible Means of Retrenchment.—The expenses of the Society may obviously be reduced by the adoption of more or less drastic restrictive measures, such as the following:

1. That the general distribution of preprints be limited to committee reports only. This measure would have effected an estimated saving of about $1000 in connection with this meeting.

2. That the activities of the Society be confined wholly to the work of technical committees which are steadily increasing in number and entering new fields. This policy of excluding from the

Proceedings papers from individuals is followed by several national technical societies.

It is believed, however, that either of these two measures would be viewed as a step backward, and thus as one which has never yet been taken in the history of the Society. Other means that may be suggested are:

3. That the Year-Book be made a biennial publication and that during the alternating years supplementary matter be issued in separate form.

4. That the Year-Book be converted to the form of a loose-leaf binder of standard pattern, and that only new and revised standards and a revised table of contents be furnished to the members annually for their files.

Either of the last two measures, especially 4, would result in a large saving of expense, as is evident from the fact that the 1914 Year-Book (500 pp.) contains an increase of 99 pages over the previous one, and the 1915 Year-Book will be considerably larger.

Summary.—It has been made clear in the foregoing that since the doubling of the dues five years ago the regular publications of the Society have more than doubled in volume; that the Society has issued in addition practically complete sets of preprints in connection with its annual meeting; and that the members have been relieved from the previous extra charge for cloth binding, those receiving half-leather binding having been given the benefit of a like reduction.

Apart from these direct gains it has been the uniform policy of the Executive Committee to avail itself freely of every opportunity to broaden and strengthen the activities of the Society, and to increase the value of membership in the organization correspondingly. The time has now come for the Society, in annual meeting assembled, to authorize the Executive Committee to continue the management of its affairs on the same progressive basis as heretofore, and in that case to authorize the opening of new sources of revenue, or to place itself on record in favor of a policy of drastic retrenchment. In that connection it may again be said that thus far in its history the Society has never taken a step backward.

ANNUAL REPORT OF THE SECRETARY-TREASURER

From June 1, 1914, to June 1, 1915.

RECEIPTS.

Membership dues		$17 471.70
Sale of Publications		3 569.24
Binding Proceedings		409.00
Authors' reprints		561.57
Sales of right to reprint specifications for one year		600.00
Sale of certificates of membership		44.00
Interest on deposits		96.71
Unclassified receipts		15.75
International Association dues, June 1 to December 31, 1914		224.00
Total receipts		$22 991.97
Cash balance, June 1, 1914		7 834.60
		$30 826.57

DISBURSEMENTS.

Publications		$14 903.41
Salaries (including Secretary-Treasurer's salary at the rate of $3600 per annum)		6 298.33
Audits by public accountants		80.00
Rent and insurance, storage room		156.60
Expenses, Secretary-Treasurer's office:		
Postage and expressage	$407.71	
Miscellaneous expenses	404.81	
		812.51
Expenses, technical committees		847.32
Expenses, Nominating Committee		94.77
Net expenses, Seventeenth Annual Meeting		202.68
Certificate of membership, cost of plate and engrossing		126.05
Joint Conference on Methods of Tests and Standard Specifications for Cement		263.36
Refund of excess remittances		10.75
Unclassified disbursements		7.00
Remitted to International Association:		
Dues, April 1 to December 31, 1914	$568.00	
Less expenses	25.00	
		543.00
Total disbursements		$24 345.78
Cash balance, June 1, 1915		6 480.79
		$30 826.57

ANALYSIS OF DISBURSEMENTS FOR ACCOUNT OF PUBLICATIONS.

	Clerical Services.	Printing and Mailing.	Total.
Membership pamphlet	$86.60	$555.10	$641.70
Year-Book	102.69	966.79	1 069.48
Proceedings	599.79	8 464.24	9 064.03
Reports of Committee D-1	.94	188.79	189.73
Circulars to members	.....	589.57	589.57
Preprints	.....	2 039.92	2 039.92
Reprints	2.40	439.05	441.45
Specifications	6.00	220.69	226.69
Miscellaneous	147.94	492.90	640.84
	$946.36	$13 957.05	$14 903.41

COMMITTEE FUNDS.

Committee A-5.

Receipts	$2 500.00	
Disbursements	.....	
Cash balance, June 1, 1915		$2 500.00

Committee C-9.

Receipts	$900.00	
Disbursements	151.35	
Cash balance, June 1, 1915		748.65

Committee D-1.

Cash balance, June 1, 1914	$143.93	
Disbursements	73.40	
Cash balance, June 1, 1915		70.53
Total cash balance, committee funds, June 1, 1915		$3 319.18

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

January 1 to June 1, 1915.

Dues collected	$1 768.00	
Less expenses	21.54	
Cash balance, June 1, 1915, held in trust pending action of the I. A. T. M. Council, after the close of the European war		$1 746.46

Proposed Amendment of the By-Laws.— As announced in a recent circular to members the Executive Committee has decided to recommend the following amendments, which, if adopted, will result in:

1. The reduction of the age limit for Junior Members from 30 to 25 years;

2. The requirement of initiation fees of $10 for Members and $5 for Junior Members, the latter being subject to a supplementary fee of $5 on their transfer to the grade of Member;

3. The use of the inclusive term "Standards" for (*a*) Standard Specifications, (*b*) Standard Methods, (*c*) Standard Tests, and (*d*) Standard Definitions;

4. The requirement that in general proposed new Standards or proposed amendments of existing Standards shall be published in the Year-Book for one year as "Tentative Standards" on which written discussions addressed to the appropriate committee shall be invited.

PROPOSED AMENDMENTS OF BY-LAWS.[1]

(For present by-laws see 1914 Membership Pamphlet, pp. 7–13.)

ARTICLE I.

SECTIONS 2 AND 3. Strike out "thirty" and substitute "twenty-five."

ARTICLE III.

SECTION 2.—After the first sentence introduce the sentence: "The procedure governing the transmission of such recommendations shall be designed to ensure secrecy as to individual authorship."

SEC. 6.—At the end of this section add the sentence: "In case the official ballot contains more than one nomination for any given office the method of voting shall be by secret ballot."

ARTICLE VI.

Strike out the present Article VI and substitute the following:

[1] For action taken on these amendments, see pp. 13 and 20.—ED.

ARTICLE VI.

PROCEDURE GOVERNING THE ADOPTION OF STANDARDS.

SECTION 1.—The term "Standards" shall be applied collectively to standard specifications, standard tests, standard methods, and standard definitions.

Proposed new standards or proposed amendments of existing standards shall be presented at the annual meeting. At this meeting amendments may be made by a two-thirds vote of those voting. The proposed new standards or the proposed amendments of existing standards, as presented or as amended, shall be printed, on two-thirds vote of those voting, in the Year-Book under a section designated "Tentative Standards," on which written discussions addressed to the appropriate committee shall be invited. At the next annual meeting these proposed new standards or proposed amendments of existing standards shall be subject to amendment by a two-thirds vote of those voting, and to reference by a like vote to letter ballot of the Society. A two-thirds vote of those voting shall be required for adoption.

The above requirement by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one year may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the annual meeting at which they are first presented. In that case the above provisions as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected.

The term "Recommended Practice" shall be applied to processes and methods not ordinarily subject to contract between purchaser and manufacturer. The above requirements governing action on new standards or proposed amendments of existing standards shall be applicable also to proposed Recommended Practice.

ARTICLE VII.

SECTION 1.—After the second sentence insert the following: "The initiation fee for Members shall be $10 and for Junior Members $5. Junior Members shall be subject to a supplementary initiation fee of $5 on being transferred from the grade of Junior Member to that of Member."

SEC. 3.—Strike out Section 3 and substitute the following:

SEC. 3.—Any member may become a Life Member by paying to the Society a sum determined by the Executive Committee which shall represent the present value of the membership dues as established for the fiscal year in which the application is made, for his prospective life, calculated according to his age under the Table of Expectancy based upon the American Experience Table of Mortality, with interest compounded annually at three per cent.

The cost of membership in perpetuity, to corporations, firms, technical or scientific societies, teaching faculties or libraries shall be two hundred dollars ($200).

The Executive Committee further recommends that if the above amendments of the by-laws should be adopted by the Society, they be not made applicable as regards the supplementary initiation fee of $5 to those of the present Junior Members whose age will exceed 25 years at the beginning of the ensuing fiscal year.

In addition to the foregoing the following amendment of the by-laws was announced on behalf of the Executive Committee in a recent circular to members, in compliance with the requirements of the by-laws, and merely for the purpose of making its consideration possible at the annual meeting, the Executive Committee not being prepared to recommend that it be or be not adopted by the Society:

ARTICLE VII.

SECTION 1.—Strike out "$10" and "$5" and substitute "$12.50" and "$6".

The effect of this amendment has received previous attention in the discussion of Finances.

Nomination of Officers.—The operation of the by-laws governing appointments of members of the nominating committee for officers, and the nomination of officers, have been reported in detail in recent circulars to members and also appear in the appended "Abstracts of the Minutes of the Executive Committee," for the meetings held on January 12 and April 13, 1915.

Report on Resolutions at last Annual Meeting.—At the last annual meeting the following resolutions were adopted:

WHEREAS, In the report of Committee C-6 on Standard Tests and Specifications for Drain Tile, presented at this meeting, it is stated in substance that "Satisfactory and definite specifications for quality of tile" require (*a*) Standard Specifications for Strength Tests and (*b*) the Definition of Practice in Tile Drain Design and Construction, and

WHEREAS, The proposed standards and practice embodied in the report of Committee C-6 were referred without debate to letter ballot of the Society, and

WHEREAS, This is the first instance in which proposed standard specifications of the Society are based on prescribed engineering design and construction, and

WHEREAS, It is the sense of this meeting that matters of engineering design and construction do not, in general, properly fall within the province of the Society, be it therefore,

Resolved, (*a*) That the Executive Committee be hereby instructed to consider the general questions involved in such a departure from the previous policy of the Society, and (*b*) that the Executive Committee and Committee C-6 be jointly instructed to consider the particular questions involved in this instance, and that the findings be reported to the Society at the next annual meeting.

The Executive Committee concurs in the view expressed in the above resolutions that matters of engineering design and construction do not in general properly fall within the province of the Society and it has been informed that this is also the sense of Committee C-6. In preparing the proposed Standard Tests and Specifications for Drain Tile last year Committee C-6 considered it difficult, if not impossible, however, to adhere to that principle without detracting seriously from the value of the specifications. The committee proposes to subject these specifications to a critical revision in the light of further tests now in progress, and with a view of seeking the best means of minimizing reference to matters of engineering design and construction. It accordingly seems desirable that this phase of the resolution should not be reported on pending further consideration on the part of the Executive Committee and Committee C-6, after the proposed revision of the specifications has been completed in at least a preliminary way.

International Association for Testing Materials.—The next International Congress, which was to have been held on August

12–17, 1915, at Petrograd, Russia, has been indefinitely postponed on account of the European war. The members of this association have been officially notified that they will not be held liable for dues from and after the beginning of the current fiscal year, January 1, 1915, "until the Council, after the change in the political situation, takes further action." The Secretary-Treasurer of the American Society has accordingly been instructed to notify those American members whose dues in the International Association for the current fiscal year have already been paid, that their remittances will be held in trust pending the adjustment of this matter, but that payments will be refunded at any time on individual request.

An announcement to the above effect was embodied in a recent circular to members from which the following paragraph is quoted:

> "It is earnestly recommended that the American members of the International Association take no steps towards withdrawing from the International Association during this critical period in its history, and especially in view of the decision to suspend their dues pending action by the Council following the close of the European war."

Respectfully submitted on behalf of the Executive Committee,

A. W. GIBBS,
President.

EDGAR MARBURG,
Secretary-Treasurer.

[EDITOR'S NOTE.—The proposed amendments of the by-laws, as amended at the annual meeting (see page 20), were adopted by letter ballot of the Society on August 21, 1915. The by-laws in their amended form appear on pages 7–14 of the 1915 Membership Pamphlet.]

APPENDIX.

ABSTRACT OF THE MINUTES OF THE EXECUTIVE COMMITTEE.

REGULAR MEETING, July 1, 1914.—Hotel Traymore, Atlantic City, N. J. Present: Mr. A. W. Gibbs, President; Mr. Richard Moldenke and Mr. A. A. Stevenson, Vice-Presidents; Genl. W. H. Bixby, Mr. John Brunner, Mr. F. H. Clark, Mr. Robert Job, Mr. F. W. Kelley, Mr. A. Marston, Mr. Albert Sauveur, and Mr. S. S. Voorhees, Members of Executive Committee; Mr. Edgar Marburg, Secretary-Treasurer; and, on invitation, Mr. C. S. Churchill, Mr. J. B. Lober, and Mr. A. N. Talbot of the outgoing Executive Committee.

The Secretary-Treasurer reported that favorable action had been taken on 79 applications for membership, and that the Society had suffered the loss by death of two members, making the total membership in the Society on June 30, 1913, 1687.

The Secretary-Treasurer presented a report from Messrs. John Heins & Co., Public Accountants and Auditors, certifying to the examination of the books and accounts of the Society for the six months ended June 24, 1914, and attesting to their correctness.

On motion of the chairman of the Finance Committee, the Secretary-Treasurer was instructed to again call the attention of the officers of the technical committees in general to the Regulations Governing Technical Committees requiring the previous authorization by the Executive Committee of prospective expenditures.

The President announced the appointment of the following Finance Committee: Mr. A. A. Stevenson, Chairman, Genl. W. H. Bixby, and Mr. F. H. Clark.

The Secretary-Treasurer reported the following results on the letter ballot of Committee A-7 on the Tempering and Testing of Steel Springs, on the proposal to discharge that committee and to authorize Committee A-1 on Standard Specifications for Steel to enlarge the functions of its present Sub-Committee IV on Spring Steel to include the consideration of Steel Springs, with the understanding that that sub-committee would then be designated Sub-Committee IV on Spring Steel and Steel Springs: Affirmative 7; Negative 4; Not Voting 4; Total 15.

On motion it was decided to put this proposed change into effect.

The provisional authorization by the President by which the Iowa State College was permitted to incorporate in one of its Bulletins the report of Committee C-6 on Standard Tests and Specifications for Drain Tile, with due credit to the Society, was approved with an expression of the grateful recognition on the part of the Executive Committee of the generous cooperation

of the Iowa State College in lending financial support and otherwise furthering the activities of this committee.

The Secretary-Treasurer announced that, in pursuance of previous authorization, the President and Secretary-Treasurer had selected the personnel of Committee C-9 on Standard Tests of Concrete and Concrete Aggregates, and had appointed Mr. Sanford E. Thompson as temporary chairman.

The provisional approval by the President of the recommendation of Col. B. W. Dunn, Chairman of Committee D-10 on Standard Specifications for Shipping Containers, that he be authorized to give advance general publicity through extraneous channels to matters bearing on the work of that committee, was approved.

The Secretary-Treasurer reported the recommendation of Committee D-7 that its designation be changed from "Standard Specifications for the Grading of Structural Timber" to "Standard Specifications for Timber." This recommendation was approved.

Mr. Edgar Marburg, as chairman of Committee E-6 on Papers and Publications, recommended that that committee be authorized to make the following amendments in the regulations governing papers, committee reports, etc.

That the regulation:

"The committee reserves the right to reject papers received too late for advance printing although exceptions will be authorized at the discretion of the committee,"

be amended by changing the words "advance printing" to "printing and advance circulation," and by changing the word "will" to "may."

The adoption of the following new regulations:

"Papers provisionally accepted by title only, and of which the manuscripts have not been received before the final program goes to press, shall not be announced by title on this program. Their authors shall be notified, however, that such of these papers as may subsequently be accepted will be introduced at the end of the appropriate sessions and read by title or otherwise, as time may admit."

On motion these recommendations were approved.

The Secretary-Treasurer presented correspondence with Mr. S. G. Webb and Mr. R. J. Wig relative to the proposed creation of a committee on Standard Specifications for Gypsum and Gypsum Products.

It was decided to authorize the creation of such a committee and to leave the determination of the personnel with power to the President-elect, the retiring President and the Secretary-Treasurer.

The Secretary-Treasurer presented correspondence with the Atlas Portland Cement Co. and the United States Rubber Co. recommending the creation of a committee on Standard Tests of Textile Fabrics. This recommendation was approved and the appointments on this committee were left with power to the President and Secretary-Treasurer.

The Secretary-Treasurer presented a letter under date of June 30 from the American Society of Mechanical Engineers inviting the cooperation of the Society in the preparation of a standard boiler code.

On motion the President was authorized to appoint a committee to attend a proposed general conference on this subject in the A. S. M. E. rooms on September 15, 1914, this committee consisting of the chairman of Committee A-1 on Standard Specifications for Steel, and the chairmen of such sub-committees of Committee A-1 as may be concerned with any phase of the general subject, with the understanding that the position of this committee in its relation to this conference is to be governed by the Regulations Governing Technical Committees by which "such relations shall entail no obligations at variance with these regulations and shall impose no restrictions upon the free and independent action of the committee."

REGULAR MEETING, October 13, 1914.—Engineers' Club, Philadelphia. Present: Mr. A. W. Gibbs, President; Mr. John Brunner, Genl. W. H. Bixby, Mr. F. H. Clark, and Mr. S. S. Voorhees, Members of Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary-Treasurer reported that favorable action had been taken on 40 applications for membership, and that the Society had suffered the loss by death of two members, making the total membership in the Society on September 30, 1914, 1725.

The Secretary-Treasurer presented the following report of the tellers on the recent letter ballot, Mr. J. A. Colby and Mr. L. R. Ferguson:

	Aye	Nay	Not Voting
Proposed Amendment of the By-Laws	122	1	232
PROPOSED NEW STANDARD SPECIFICATIONS.			
1. Structural Steel for Cars	131	2	222
2. Methods of Chemical Analysis for Plain Carbon Steel	160	2	193
3. Recommended Practice for the Annealing of Carbon-Steel Castings	135	0	220
4. Recommended Practice for the Heat Treatment of Case-Hardened Carbon-Steel Objects	117	0	238
5. Cold-Drawn Steel: Bessemer Automatic Screw Stock	107	3	245
6. Strength Tests of Drain Tile	89	3	263
7. Quality of Drain Tile	86	2	267
8. Recommended Practice for the Design and Construction of Tile Drain	83	1	271
9. Carbon-Steel Bars for Springs (*as amended*)	109	0	246

PROPOSED REVISIONS IN STANDARD SPECIFICATIONS.	Aye	Nay	Not Voting
1. Carbon-Steel Rails	126	5	224
2. Low-Carbon-Steel Splice Bars	126	4	225
3. Medium-Carbon-Steel Splice Bars	126	4	225
4. High-Carbon-Steel Splice Bars	114	4	237
5. Extra-High-Carbon-Steel Splice Bars	108	4	243
6. Structural Steel for Bridges	148	2	205
7. Structural Nickel Steel	130	3	222
8. Structural Steel for Buildings	151	1	203
9. Structural Steel for Locomotives	126	3	226
10. Billet-Steel Concrete Reinforcement Bars	134	5	216
11. Carbon-Steel and Alloy-Steel Forgings	134	2	219
12. Carbon-Steel Car and Tender Axles	126	2	227
13. Cold-Rolled Steel Axles	101	6	248
14. Recommendations relative to fracture of 2 and 8-in. Steel Tension Test Specimens	151	5	199
15. Staybolt Iron	81	7	267
16. Magnetic Tests of Iron and Steel	45	1	309
17. Spelter	68	0	287
18. Manganese-Bronze Ingots	62	2	291
19. Quenched-and-Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (*as amended*)	128	6	221
20. Carbon-Steel Forgings for Locomotives (*as amended*)	120	1	234
21. Locomotive Cylinders (*as amended*)	69	6	280

Total number of legal votes cast.....355.

It was decided, after the appearance of the Proceedings, to call attention in a subsequent circular to members to the paper and discussion under the title "A Critical Review of the Procedure Governing the Adoption of Standards" and, in that connection, to take a straw vote by letter ballot with a view of ascertaining the sentiment in favor and against the retention of the letter ballot of the membership at large on the adoption of standards. It is to be made clear in the circular that the Executive Committee will make recommendations in this matter in its next annual report to the Society, and in case a majority vote should be in favor of abrogating the letter ballot the Executive Committee will not necessarily allow that circumstance to determine its recommendation; for if a substantial minority sentiment should favor the retention of the letter ballot it may be thought unwise, or at least inexpedient, to recommend its abrogation.

Correspondence was presented recommending the creation of a committee on Standard Specifications for Hollow Building Tile. It was decided to authorize the President and Secretary-Treasurer to appoint a nucleus for

such a committee which is to be instructed to report to the Executive Committee in advance of the next quarterly meeting as to the advisability of appointing an enlarged and permanent committee, and also as to the need of funds for conducting investigations and the probability of obtaining funds for that purpose from the commercial interests affected.

The provisional approval of the President of publishing in the Year-Book as Tentative Specifications, certain specifications reported by Committee C-7 on Standard Specifications for Lime, and by Committee A-8 on Standard Specifications for Cold-Drawn Steel was, on motion, approved.

It was decided to refer the proposed provisional tests recommended by Committee D-4 on Road Materials to a joint committee consisting of sub-committees of Committee D-4 and Committee C-9 on Standard Tests of Concrete Aggregates.

The same action was taken with respect to the standard definitions of terms applicable to materials relating to roads and pavements proposed by Committee D-4.

The Secretary-Treasurer was instructed to take measures by which the nominations for membership on the Nominating Committee shall be secret.

The Secretary-Treasurer reported that on the recommendation of Mr. C. D. Young, Chairman of Committee A-1, and with the provisional approval of President Gibbs, the personnel of the committee appointed to cooperate with the American Society of Mechanical Engineers in the preparation of a boiler code differed somewhat from the personnel according to a strict consideration of the terms of the motion covering this item adopted at the last meeting of the Executive Committee, the revised personnel being as follows:

*F. J. Cole	*A. A. Stevenson
*J. H. Gibboney	*H. V. Wille
C. L. Huston	C. D. Young (*ex-officio*)
*H. B. MacFarland	Edgar Marburg (*Chairman*)

(* Chairman of a sub-committee)

On motion the action of the President in this matter was approved.

Mr. Edgar Marburg, as chairman of the above committee, presented a detailed report (on file) to the effect that seven of the eight members of the committee were in attendance at the "Hearing" conducted by the A. S. M. E. Boiler Code Committee in New York on September 15, and agreed that as the representatives of the Society they were not authorized to have their participation in the work of the A. S. M. E. committee limited to the giving of testimony without the right to participate by voice and vote in the deliberations of the A. S. M. E. committee concerning specifications for boiler material, and also without the right of introducing a minority report, if they should see fit to do so. He stated that this position on the part of the committee had previously been approved by President Gibbs.

This report was accepted with the understanding that the Society as such cannot cooperate with the A. S. M. E. committee on the basis desired by that committee.

It was decided to take steps towards the following changes in the by-laws:

Art. VI, Section 1.—Strike out the word "definitions" throughout this section.

Add the following new section 2 to this Article:

"SEC. 2.—The procedure governing action on proposed new standard definitions or proposed amendments of existing standard definitions shall be in precise conformity with that above defined in relation to "specifications," except that such new or amended definitions shall not be referred to letter ballot of the Society prior to the annual meeting following their publication in the Proceedings of the Society."

The Secretary-Treasurer reported the death of Mr. A. Martens, Vice-President of the International Association for Testing Materials, which occurred on July 24, 1914.

REGULAR MEETING, January 12, 1915.—Engineers' Club, Philadelphia. Present: Mr. Richard Moldenke and Mr. A. A. Stevenson, Vice-Presidents; Mr. Robert Job, Mr. F. W. Kelley and Mr. S. S. Voorhees, Members of Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary-Treasurer reported that favorable action had been taken on 57 applications for membership, that the Society had suffered the loss by death of 2 members. and that 31 members had resigned, making the total membership in the Society on January 1, 1915, 1749.

The Secretary-Treasurer presented a report from Messrs. John Heins & Co., Public Accountants and Auditors, certifying to the examination of the books and accounts of the Society for the six months ended December 31, 1914, and attesting to their correctness.

A detailed report was presented on behalf of the tellers, Messrs. G. H. Clamer and J. A. Colby, on the vote for the recommendations for appointment on the nominating committee for officers, from which it appeared that 155 legal ballots had been cast which had resulted in one or more votes for 157 members of whom, exclusive of the vote for members of the Executive Committee, two members had received 10 votes, one 9 votes, two 7 votes, two 6 votes, three 4 votes, twelve 3 votes, and the remainder fewer than 3 votes. It was accordingly decided to make the following appointments on the Nominating Committee:

Members.	*Alternates.*
J. A. Capp;	G. Aertsen;
R. L. Humphrey;	G. S. Webster;
S. T. Wagner;	C. E. Skinner;
C. D. Young;	J. J. Shuman;
S. V. Hunnings;	L. W. Page;
G. W. Thompson;	P. H. Walker;

the six members being those who had received the highest number of votes on the ballot and the alternates being chosen from among those who had received three or more votes, and with a view of making the group as thoroughly representative as possible.

The appointment by the President of the following delegates to technical conventions were reported:

Fifth American Good Roads Congress, Chicago, December 14–18, 1914, A. H. Blanchard, W. W. Crosby, Prévost Hubbard.

Second Annual Industrial Welfare and Efficiency Conference, Harrisburg, Pa., November 17–19, 1914, J. V. W. Reynders.

An invitation to the Society from the American Society of Mechanical Engineers to appoint a representative on the Joint Committee on Standards for Graphic Presentation was presented.

It was decided to accept this invitation and to leave the selection of the representative with power to the President and Secretary-Treasurer.

The Secretary-Treasurer reported the following appointments on two joint committees authorized at the last meeting of the Executive Committee, explaining that the addition of representatives of Committee D-8 had since been provisionally approved by the President, subject to confirmation at this meeting:

JOINT COMMITTEE ON PROPOSED PROVISIONAL TESTS RECOMMENDED BY COMMITTEE D-4 ON STANDARD TESTS FOR ROAD MATERIALS.

Representing Committee D-4 on Standard Tests for Road Materials:	*Representing Committee C-9 on Standard Tests of Concrete and Concrete Aggregates:*
A. H. Blanchard, *Chairman;*	Cloyd M. Chapman;
A. N. Johnson;	D. A. Abrams;
F. P. Smith.	George L. Lucas.

JOINT COMMITTEE ON STANDARD DEFINITIONS OF TERMS APPLICABLE TO MATERIALS RELATING TO ROADS AND PAVEMENTS—PROPOSED BY COMMITTEE D-4 ON STANDARD TESTS FOR ROAD MATERIALS.

Representing Committee D-4 on Standard Tests for Road Materials:	*Representing Committee C-9 on Standard Tests of Concrete and Concrete Aggregates:*
Prévost Hubbard, *Chairman;*	L. R. Ferguson;
P. P. Sharpless;	J. L. Miner;
W. W. Crosby.	H. A. Moore.

Representing Committee D-8 on Waterproofing Materials.

S. R. Church;
K. G. Mackenzie;
R. J. Wig.

On motion these appointments were approved.

A recommendation from Committee A-1 on Standard Specifications for Steel was presented to the effect that the appointment of a new committee, to be known as Committee E-3 on Standardization of Pipe Threads, be

authorized, with the understanding (1) that the members of the present Sub-Committee IX on Steel Tubing and Pipe, of Committee A-1, shall be eligible to membership on that committee; (2) that Mr. H. V. Wille, the chairman of Sub-Committee IX, be appointed to the chairmanship of Committee E-3; (3) that this committee be authorized to invite other technical organizations, on approval of the Executive Committee, to appoint committees to cooperate with Committee E-3 under the general auspices of that committee and the American Society for Testing Materials; (4) that any proposed report from Committee E-3 be presented for consideration to Committee A-1 before its presentation to the Society; and (5) that the above proposed arrangement shall be subject to the approval of Mr. H. V. Wille.

The above recommendations on the part of Committee A-1 were approved.

It was reported that the recommendation of Mr. F. W. Kelley to consider the creation of a committee on paper bags had recently been met in a way satisfactory to Mr. Kelley through the willingness of Committee D-10 on Standard Tests and Specifications for Shipping Containers to add this item to its program.

Committee E-5 on Regulations Governing the Form but not the Substance of Specifications recommended the substitution of the following for the present Article VI of the by-laws, which was approved with the understanding that this amendment would be recommended for adoption by the Society at the next annual meeting.

ARTICLE VI.

PROCEDURE GOVERNING THE ADOPTION OF STANDARDS

SECTION 1.—The term "Standards" shall be applied collectively to standard specifications, standard methods, standard tests, and standard definitions.

Proposed new standards or proposed amendments of existing standards shall be presented at the annual meeting. At this meeting amendments may be made by a two-thirds vote of those voting. The proposed new standards or the proposed amendments of existing standards, as presented or as amended, shall be printed in the Year-Book under a section designated "Tentative, Standards," on which written discussions addressed to the appropriate committee shall be invited. At the next annual meeting these proposed new standards or proposed amendments of existing standards shall be subject to amendment by a two-thirds vote of those voting, and to reference by a like vote to letter ballot of the Society. A two-thirds vote of those voting shall be required for adoption.

The above requirement by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one year may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the annual meeting at which they are first presented. In that case the above provisions as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected.

The term "Recommended Practice" shall be applied to processes and methods not ordinarily subject to contract between purchaser and manufacturer. The above requirements governing action on new standards or proposed amendments of existing standards shall be applicable also to proposed Recommended Practice.

It was reported on behalf of Committee E-5 that it had carefully considered the question referred to it by the Executive Committee as to the desirability of more direct control on the part of that committee of the personnel of the technical committees, either directly or through a special supervisory committee, and that it had been unanimously decided to recommend to the Executive Committee that the present practice in such matters be adhered to.

Favorable action was taken on the following proposed amendments of the by-laws, with the understanding that these amendments will be recommended at the next annual meeting of the Society for adoption.

ARTICLE III.

NOMINATION OF OFFICERS.

Sec. 2.—Insert the following sentence after the first sentence:

The procedure governing the transmission of such recommendations shall be designed to ensure secrecy as to individual authorship.

Sec. 6.—Add the following sentence:

In case the official ballot contains more than one nomination for any given office the method of voting shall be by secret ballot.

ARTICLE VII

DUES.

Strike out the present Sec. 3 and substitute the following:

SEC. 3.—Any member may become a Life Member by paying to the Society a sum determined by the Executive Committee which shall represent the present value of the membership dues as established for the fiscal year in which the application is made, for his prospective life, calculated according to his age under the United States Actuarial Table, with interest compounded annually at three per cent.

The cost of membership in perpetuity, to corporations, firms, technical or scientific societies, teaching faculties, or libraries shall be two hundred dollars ($200).

The recommendation of the International Association for Testing Materials, previously endorsed by Mr. R. W. Hunt, American member of Council, for the appointment of Mr. Cloyd M. Chapman on International Committee 41 on Investigations of Reinforced Concrete, was approved.

It was decided to recommend amendments of the by-laws to the following effect:

1. The decrease of the age limit for Junior Members from thirty years to twenty-five years;

2. The requirement of the payment of initiation fees of $10 for Members and $5 for Junior Members.

It was estimated that these measures would yield an annual increase of revenue of about $2500, after allowing for a loss of 25 per cent in Junior membership.

REGULAR MEETING, April 13, 1915.—Engineers' Club, Philadelphia. Present: Mr. A. W. Gibbs, President; Mr. Richard Moldenke and Mr. A. A. Stevenson, Vice-Presidents; Genl. W. H. Bixby, Mr. John Brunner, Mr. F. H. Clark, Mr. F. W. Kelley, and Mr. S. S. Voorhees, Members of Executive Committee; Mr. Edgar Marburg, Secretary-Treasurer; and on invitation Mr. Mansfield Merriman.

The following report of the Nominating Committee was presented, bearing the signatures of those members in attendance at the meeting of that committee:

"A meeting of the Committee on Nomination of Officers convened in New York, March 6. There were present Messrs. J. A. Capp, R. L. Humphrey, S. V. Hunnings. A. N. Talbot, G. W. Thompson, S. T. Wagner and C. D. Young.

The following nominations were unanimously agreed to:

For President: Mansfield Merriman.

For Vice-President: W. H. Bixby.

For Members of Executive Committee: J. H. Gibboney, W. K. Hatt, J. A. Mathews and Edward Orton, Jr.

The Secretary-Treasurer reported that favorable action had been taken on 94 applications for membership; that the Society had suffered the loss by death of one member; that 43 members had resigned; and that 61 members had been dropped for non-payment of 1914 dues; making the total membership in the Society on April 1, 1738.

The recommendation that the publication of "Selected Specifications from Miscellaneous Sources," which comprise 32 pages in the 1914 Year-Book, be herafter omitted was, on motion, approved. This proposal had previously been referred to Committee A-1 on Standard Specifications for Steel, whose Advisory Committee had unanimously expressed itself as not opposed to this proposed recommendation.

The proposed change of title of Committee E-3 from "On Standardization of Pipe Threads" to "On Revision of Pipe Threads," and the addition to the committee of the members of Sub-Committee I of Committee A-2 on Wrought Iron, was, on motion, approved.

The recommendation was presented on behalf of Committee E-5 that its title be changed from "On Regulations Governing the Form but not the Substance of Specifications" to "On Technical Committees," followed by the explanatory note: "The duties of this committee are the formulation of (*a*) Regulations Governing Technical Committees, (*b*) Regulations Governing the Form but not the Substance of Specifications, and (*c*) the Classification of Standards."

This recommendation was approved.

A report from Mr. J. O. Handy, chairman of the Sub-Committee on Finance of Committee A-5 on Corrosion of Iron and Steel, to the effect that that committee had collected the sum of $2500 for its proposed investigations, was presented together with a list of the subscribers and the amounts of their individual subscriptions.

The Secretary-Treasurer presented a report from Mr. Edward Orton, Jr., chairman of the provisional committee on Standard Specifications for Hollow Building Tile, which had been instructed to report to the Executive Committee "on the advisability of appointing an enlarged and permanent committee, and also as to the need of funds for conducting investigations and the probability of obtaining funds for that purpose from the commercial interests affected" (see minutes of Executive Committee, October 13, 1914), with an accompanying communication from Mr. C. T Harris, Secretary of the Hollow Building Tile Manufacturers' Association of America, to Mr. Orton informing him of the adoption of the following resolutions on the part of his association:

1. That the Hollow Building Tile Manufacturers' Association of America join the American Society for Testing Materials through its secretary, with the view of cooperating towards the end of testing, standardizing, specifying and codifying hollow building tile as a structural material.

2. That the Hollow Building Tile Manufacturers' Association of America appropriate the sum of $600 for conducting this work for the first six months, such a sum to be given into the hands of the chairman of the committee of the American Society for Testing Materials at the rate of $100 at a time, to be expended as he may direct and accounted for by him upon requesting the next amount.

Provided, (*a*) That a separate committee of the American Society for Testing Materials be appointed to handle this subject; (*b*) that such a committee shall contain place for eight producers of hollow tile; (*c*) that the members of the two committees of the Hollow Building Tile Manufacturers' Association of America on Tests and Loads, and Codes and Specifications, shall be members of the committee; and (*d*) that those members of these committees who are not members of the American Society for Testing Materials shall join the Society.

The terms of these resolutions were approved, with the understanding that the representation of the producing interests referred to in Sections *b* and *c* shall not exceed eight.

It was further decided to create a permanent committee to be known as Committee C-10 on Standard Specifications for Hollow Building Tile, the determination of the appointments on this committee being left with power to the President and the Secretary-Treasurer.

The President was authorized to appoint a sub-committee under the chairmanship of Mr. A. A. Stevenson, to communicate with the governing boards of other leading engineering societies with a view of considering a policy of closer cooperation with such organizations to the mutual advantage of all concerned, and to report its findings, in due course, to the Executive Committee.

The reference to certain Standard Specifications of the American Society for Testing Materials in the American Society of Mechanical Engineers' Boiler Code was considered, and it was decided to authorize Mr. F. H. Clark to take suitable steps towards the publication in the Proceedings of the American Society of Mechanical Engineers of the differences between the specifications of the American Society for Testing Materials and those in the Boiler Code.

On motion it was decided to recommend the following amendments of the by-laws at the approaching annual meeting of the Society:

Art. I, Sec. 2 and 3.—Strike out the word "thirty" and substitute "twenty-five."

Revised Art. VI, Sec. 1, paragraph 2.—Insert the words "on two-thirds majority of those voting" after the words "shall be printed."

Art. VII, Sec. 1.—Insert the following after the second sentence: "The initiation fee for Members shall be $10 and for Junior Members $5. Junior Members shall be subject to a supplementary initiation fee of $5 on being transferred from the grade of Junior Member to that of Member."

The recommendation of the Secretary-Treasurer, that if these amendments to the by-laws should be adopted by the Society, they be not made applicable as regards the supplementary initiation fee of $5 to those of the present Junior Members whose age will exceed 25 years at the beginning of the ensuing fiscal year, was approved.

The Secretary-Treasurer reported that the recent straw ballot had resulted in 281 affirmative and 115 negative votes on the continuation of the present policy, by which a letter ballot of the Society at large is prescribed as the final step in the adoption of standards. On motion it was accordingly decided to recommend no change in that policy.

The appointments on the Entertainment Committee for the annual meeting were left with power to the Secretary-Treasurer.

Committee E-6 on Papers and Publications was authorized to prepare the program for the annual meeting.

An invitation from the Chairman of the International Engineering Congress, to be held in San Francisco, September 20-25, 1915, to the Society to appoint delegates to that congress was accepted, and these appointments were left with power to the President and Secretary-Treasurer.

The Secretary-Treasurer reported that in pursuance of correspondence initiated in this country through Mr. R. W. Hunt, the American representative on the Council of the International Association for Testing Materials, the Secretary of that Association had drawn up the following announcement to the membership of the association at large:

VIENNA, March 15, 1915.

TO THE MEMBERS of the International Association for Testing Materials.

Dear Sirs: The war has interrupted the activity of the Association. We have therefore for months been obliged to confine ourselves to the bringing of the work of the Sixth Congress to a conclusion by issuing a reprint of the Uniform Nomenclatures recommended by this Congress.

As the Association has sufficient funds to cover the administrative expenses for a long time, we beg to inform you that no member will be called upon for payment of his dues until the Council, after the change of the political situation, take further action. But non-payment will in no way interfere with membership.

Begging you to continue your confidence in the Association and its aims, we are, dear sir,

Yours faithfully,

ERNST REITLER,
General Secretary.

The Secretary-Treasurer was instructed to call the attention of the American members of the International Association in the next "Circular to Members" to the fact that the payment of membership dues in the International Association had been suspended from and after the beginning of the current fiscal year, January 1, 1915, pending action after the close of the European war on the part of the Council of that Association, and to notify those members whose dues for the current year have already been paid that their remittances would be held in trust pending the adjustment of this matter, but that payments will be refunded at any time on individual request.

REPORT OF COMMITTEE A-1

ON

STANDARD SPECIFICATIONS FOR STEEL.

Since the last annual meeting, Committee A-1 has held three well-attended meetings. There have been no important changes in sub-committees or in the personnel of the committee, which now numbers 96 members, represented by 115 individuals.

The recommendations affecting standards which the committee presents this year to the Society have originated in the respective sub-committees and were carefully considered by the committee at its meetings before being referred to letter ballot of the committee.

Recommendations.—The recommendations of the committee affecting standards, which will be referred to in greater detail later in this report, are as follows:

I. Proposed Revisions in Present Standard Specifications.

The committee recommends that the following present standard specifications be revised in accordance with the detailed recommendations contained in Appendix II to this report, and referred to letter ballot of the Society for adoption:

1. For Structural Steel for Bridges (Serial Designation: A 7–14);

2. For Automobile Carbon and Alloy Steels (Serial Designation: A 29–14).

II. Proposed Standard Specifications and Methods.

The committee recommends that the following five proposed standard specifications and the proposed standard method, appended to this report,[1] be referred to letter ballot of the Society for adoption:

1. For Heat-Treated High-Carbon-Steel Splice Bars;

[1] These specifications and methods are not reprinted here, but they appear in the 1915 Year-Book.—Ed.

2. For Heat-Treated Carbon-Steel Track Bolts;
3. For Heat-Treated Alloy-Steel Track Bolts;
4. For Lap-Welded and Seamless Boiler Tubes for Stationary Service;[1]
5. For Welded Steel and Wrought-Iron Pipe;[1]
6. Methods for Chemical Analysis of Alloy Steels.

III. PROPOSED TENTATIVE SPECIFICATIONS.

The committee recommends that the following six proposed tentative specifications, appended to this report,[2] be printed in the Year-Book as tentative:

1. For Carbon-Steel Bars for Vehicle and Automobile Springs;
2. For Silico-Manganese-Steel Bars for Automobile and Railway Springs;
3. For Chrome-Vanadium-Steel Bars for Automobile and Railway Springs;
4. For Helical and Elliptical Springs for Railways;
5. For Alloy-Steel Forgings;
6. For Quenched-and-Tempered Alloy-Steel Axles, Shafts and other Forgings for Locomotives and Cars.

The results of the letter ballot of the committee on the above recommendations are given in the accompanying table.

The committee presents its recommendations in greater detail below. Owing to the diversity of the subjects in charge of the committee, it has been deemed best to group these recommendations in the order of the respective sub-committees directly responsible for them, so that all questions pertaining to the various specifications for a given class of material will be found together.

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[1] These specifications, which involve wrought-iron tubes and pipe, respectively, were drafted in cooperation with Committee A-2 on Standard Specifications for Wrought Iron, which has approved them with the following vote: Affirmative, 24; negative, 0; not voting, 11.

[2] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

STEEL RAILS AND ACCESSORIES (SUB-COMMITTEE I).

Proposed Standard Specifications.—As stated in its report last year,[1] the question of specifications for heat-treated splice bars and bolts has been under consideration, and as a result

Items.	Affirmative.	Negative.	Not Voting.[2]
I. PROPOSED REVISIONS IN PRESENT STANDARD SPECIFICATIONS:			
1. For Structural Steel for Bridges (A 7–14)	54	0	42
2. For Automobile Carbon and Alloy Steels (A 29–14)	45	1	50
II. PROPOSED STANDARD SPECIFICATIONS AND METHODS:			
1. For Heat-Treated High-Carbon-Steel Splice Bars	44	3	49
2. For Heat-Treated Carbon-Steel Track Bolts	47	0	49
3. For Heat-Treated Alloy-Steel Track Bolts	47	0	49
4. For Lap-Welded and Seamless Boiler Tubes for Stationary Service	42	0	54
5. For Welded Steel and Wrought-Iron Pipe	42	1	53
6. Methods for Chemical Analysis of Alloy Steels	48	0	48
III. PROPOSED TENTATIVE SPECIFICATIONS:			
1. For Carbon-Steel Bars for Vehicle and Automobile Springs	47	1	48
2. For Silico-Manganese-Steel Bars for Automobile and Railway Springs	47	1	48
3. For Chrome-Vanadium-Steel Bars for Automobile and Railway Springs	47	1	48
4. For Helical and Elliptical Springs for Railways	46	0	50
5. For Alloy-Steel Forgings	45	3	48
6. For Quenched-and-Tempered Alloy-Steel Axles, Shafts and other Forgings for Locomotives and Cars	47	3	46

Total number of ballots cast	75
Number of members who failed to vote	21
Total membership	96

the committee recommends for adoption as standard the following three specifications appended to this report:[3]

1. Specifications for Heat-Treated High-Carbon-Steel Splice Bars;

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 89 (1914).

[2] Of the 96 members of the committee, 21 failed to record a vote on any of the items listed. The numbers obtained by subtracting 21 from each number in the last column, represent the number of votes cast as "not voting" on the various items.

[3] In presenting these specifications at the annual meeting, Committee A-1 recommended certain amendments, which are given on p. 17. The specifications are not reprinted here, but they appear in amended form in the 1915 Year-Book.—ED.

2. Specifications for Heat-Treated Carbon-Steel Track Bolts;

3. Specifications for Heat-Treated Alloy-Steel Track Bolts.

Finishing Temperatures for Rails.—In a paper recently written by Messrs. G. K. Burgess, J. J. Crowe, H. S. Rawdon and R. G. Waltenburg, which was issued by the Bureau of Standards under the title "Observations on Finishing Temperatures and Properties of Rails," the Standard Specifications of the Society for Carbon-Steel Rails were criticized (1) in a general condemnation of the use of shrinkage allowance as a basis of temperature determination, and (2) in that the shrinkage permitted is too great. The committee deemed it advisable to consider these criticisms and instructed Sub-Committee I to do so. The report of the sub-committee is embodied in Appendix I to this report, and includes the results of a number of tests to establish the relation, if any, between physical properties and finishing temperatures of rails, together with such data as could be obtained on the behavior of rails in track as affected by the finishing temperature. The conclusion of the sub-committee is briefly summarized in the following excerpt from its report:

"In all of the information as to actual tests which we are able to obtain, there is lacking anything which points to such decided differences in the quality of rails rolled at varying temperatures, as theoretical considerations have led some of us to expect.

"The differences are so slight that it seems hardly justifiable to go to any great expense in determining finishing temperatures any more accurately than is possible with the shrinkage clause, which on account of its easy application is by far the most convenient means of checking the finishing temperature."

STRUCTURAL STEEL FOR BRIDGES (SUB-COMMITTEE II).

Proposed Revision in Standard Specifications for Structural Steel for Bridges.—The proposed revision indicated in Appendix II is merely designed to express more clearly and definitely the necessary requirements as to tensile strength of specimen

tests of unannealed bars to meet the required minimum tensile strength of full-size annealed eyebars, and is recommended for adoption.

SPRING STEEL AND STEEL SPRINGS (SUB-COMMITTEE IV).

Proposed Tentative Specifications for Spring Steel.—At the last annual meeting, Committee A-1 presented specifications for Carbon-Steel Bars for Railway Springs, with the understanding that the question of specifications for carbon-steel bars for automobile springs would be considered during the year. It was also stated that the preparation of specifications for alloy-steel bars for springs was under consideration.[1] As a result of its work during the year, the committee presents the following three specifications for spring steel appended to this report,[2] with the recommendation that they be accepted at this meeting and printed in the Year-Book for one year as tentative:

1. Specifications for Carbon-Steel Bars for Vehicle and Automobile Springs;
2. Specifications for Silico-Manganese-Steel Bars for Automobile and Railway Springs;[3]
3. Specifications for Chrome-Vanadium-Steel Bars for Automobile and Railway Springs.[3]

In connection with these specifications, the committee wishes to direct attention to the following features:

(*a*) The committee recommends that these specifications be accepted as tentative rather than adopted as standard, for the reason that it is not prepared at this time to specify requirements as to permissible variations in the gage and width of bars for vehicle and automobile springs and desires to give this question further consideration; in the meantime specifying that such requirements shall be agreed upon by the manufacturer and the purchaser, with an explanatory footnote stating that requirements are under consideration by the committee. It is to be noted that requirements for permissible variations in bars for railway springs have been included.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 90 (1914).

[2] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

[3] These specifications were amended at the annual meeting; see p. 18.—ED.

(*b*) The Standard Specifications for Carbon-Steel Bars for Railway Springs (Serial Designation: A 14–14),[1] above referred to, are recognized by the committee to be inconsistent, both as to substance and form, with the proposed specifications for alloy-steel bars for railway springs. However, the committee at its last meeting voted unanimously to recommend no changes in the specifications until next year, when it is expected to have the proposed tentative specifications in shape for adoption as standard.

Proposed Tentative Specifications for Steel Springs.—Sub-Committee IV enlarged its sphere of activity during the past year by preparing the Specifications for Helical and Elliptical Springs for Railways appended to this report,[2] and recommends that they be accepted at this meeting and printed in the Year-Book for one year as tentative. The committee wishes to emphasize the fact that no requirements in these specifications are to be construed as defining practice in the design of springs, the appendix having been carefully phrased to apply only to test fiber stresses and not to design fiber stresses.

STEEL FORGINGS (SUB-COMMITTEE VI).

Proposed Tentative Specifications for Alloy-Steel Forgings.—Sub-Committee VI has prepared the following two specifications for alloy-steel forgings, which are appended to this report:[2]

1. Specifications for Alloy-Steel Forgings;
2. Specifications for Quenched-and-Tempered Alloy-Steel Axles, Shafts and other Forgings for Locomotives and Cars.

The committee is not yet prepared to recommend that the first of these specifications be embodied in the Standard Specifications for Carbon-Steel and Alloy-Steel Forgings (Serial Designation: A 18–14) adopted last year,[3] and has left the requirements as to chemical composition—except in the case of phosphorus and sulfur—to be agreed upon by the manufacturer and the purchaser, quoting typical composition as represent-

[1] 1914 Year-Book, p. 80.

[2] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

[3] 1914 Year-Book, p. 93.

ing current practice. Therefore, the committee recommends: (1) that the two specifications be accepted at this meeting and printed in the Year-Book for one year as tentative; and (2) that an appropriate footnote be added to the standard specifications A 18–14 just referred to, calling attention to the Tentative Specifications for Alloy-Steel Forgings.

Referring to the Tentative Specifications for Alloy-Steel Axles, Shafts and other Forgings for Locomotives and Cars, the committee wishes to direct attention to the fact that Sections 5 and 16 differ from the corresponding sections of the Standard Specifications for Carbon-Steel Axles, Shafts and other Forgings for Locomotives and Cars (Serial Designation: A 19–14)[1] in that the former provide for the rough turning of collars, unless otherwise specified, while the latter provide that collars shall be left rough-forged, unless otherwise specified. The committee will eventually recommend that the latter specifications be changed to agree in this respect with the former, but the change is of such minor importance that it will be recommended at some later time when other more important changes may be under consideration.

The committee further recommends that the report on proof tests of finished forgings, contained in Appendix IV to its report presented last year,[2] be printed in the Year-Book for information.

Specifications for Carbon-Steel Car and Tender Axles.—The committee is cooperating with the Master Car Builders' Association in the matter of revising the drop-test requirements for car and tender axles, and expects to report on this matter next year.

STEEL CASTINGS (SUB-COMMITTEE VIII).

Sulfur for Castings for Railway Rolling Stock.—In pursuance of the purpose announced in its last report,[3] Sub-Committee VIII has considered the question of changing the requirement of 0.05 per cent of sulfur on check analysis of

[1] 1914 Year-Book, p. 100.
[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 120 (1914).
[3] *Ibid.*, p. 95.

castings for railway rolling stock (Section 23 of the Standard Specifications for Steel Castings) to provide for an allowance of 10 per cent excess (that is, 0.055 per cent) on check analysis. The sub-committee referred this question to railway members of Committee A-1, and 11 of the 15 replies received were against the proposed change. Accordingly, the committee recommends that no change be made in the present requirement.

STEEL TUBING AND PIPE (SUB-COMMITTEE IX).

Proposed Standard Specifications.—The committee recommends for adoption as standard the following specifications appended to this report:[1]

1. Specifications for Lap-Welded and Seamless Boiler Tubes for Stationary Service.
2. Specifications for Welded Steel and Wrought-Iron Pipe.

These specifications, which cover both steel and iron products, were drafted by Sub-Committee IX in cooperation with a sub-committee of Committee A-2 on Standard Specifications for Wrought Iron, and have been approved by both committees, the vote of Committee A-2 being as follows: Affirmative, 24; negative, 0; not voting, 11.

Standardization of Pipe Threads.—The question of standardization of pipe threads has been under discussion in Sub-Committee IX, in cooperation with various associations interested in this question. Recently, by action of the Executive Committee on the recommendation of Committee A-1, a new Committee E-3 on Revision of Pipe Threads has been formed under the chairmanship of Mr. H. V. Wille, the chairman of Sub-Committee IX, with the understanding that this committee will submit its findings and recommendations to Committee A-1 for review before reporting to the Society.

AUTOMOBILE STEELS (SUB-COMMITTEE X).

Proposed Revision in Standard Specifications for Automobile Carbon and Alloy Steels.—The committee, in its report last

[1] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

year,[1] announced its purpose of revising the Standard Specifications for Automobile Carbon and Alloy Steels (1) to agree in general, in so far as requirements for forgings are concerned, with the forging specifications of the Society, and (2) to harmonize, in so far as possible, the requirements of this Society and the Society of Automobile Engineers. The proposed revisions indicated in Appendix II accomplish this two-fold purpose, and the committee recommends their adoption.[2]

BOILER STEELS (SUB-COMMITTEE XI).

During the past year, Sub-Committee XI considered the question of revising the Standard Specifications for Boiler and Firebox Steel to agree with the provisions of the Boiler Code which has been drafted by the American Society of Mechanical Engineers, and reported to the committee at its last meeting that in its opinion it is not desirable to recommend any changes this year. The question will, however, be fully considered during the coming year, and reported upon at the next annual meeting.

In that connection, the committee announces its intention of giving special study to the subject of additional tests of boiler plate to determine the uniformity of the metal throughout the plate.

METHODS OF CHEMICAL ANALYSIS (SUB-COMMITTEE XII).

Proposed Standard Specifications for Methods of Chemical Analysis of Alloy Steels.—Supplementing the Methods for Chemical Analysis of Plain Carbon Steel submitted last year and adopted by the Society, Sub-Committee XII has drafted Methods for Chemical Analysis of Alloy Steels, covering Nickel, Chrome-Nickel, Vanadium, Chrome-Vanadium and Silico-Manganese Steels, which are appended to this report,[3] and the committee recommends that they be adopted as standard. In obtaining information upon which to base these methods, carefully detailed outlines from 73 laboratories, comprising 35 steel com-

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 95 (1914).

[2] In presenting these revisions at the annual meeting, Committee A-1 recommended certain amendments, which are given on p. 17.—ED.

[3] These methods are not reprinted here, but they appear in the 1915 Year-Book.—ED.

panies, 12 testing laboratories, 12 railroad laboratories, and 14 other consumers, were considered, and it is felt that the methods proposed are thoroughly representative.

Test Ingots for Ladle Analysis.—The committee reports progress on this question. Sub-Committee XII has secured ingots from a number of steel companies. The study of these ingots will cover the chemical survey, with special reference to the location of the drill hole from which is obtained drillings for ladle analysis, and the microscopic survey showing structural conditions in longitudinal and transverse sections.

METHODS OF PHYSICAL TESTS (SUB-COMMITTEE XIII).

Relation between Yield Point and Tensile Strength of Steel.—This question was referred to Committee A-1 two years ago.[1] Last year the committee reported progress. The committee now recommends, in the light of tests which have been made by Sub-Committee XIII to date, that the ratio of yield point to tensile strength be allowed to stand at 0.5, as printed in the present specifications for steel and steel products. The results of the tests have been transmitted to Committee E-1 on Standard Methods of Testing, and it is understood that that committee will make further tests during the coming year.

PERMISSIBLE VARIATIONS IN WEIGHT AND GAGE OF SHEARED PLATES.

The report of the committee last year,[2] contained a table of permissible variations in weight and gage of sheared plates proposed by The Association of American Steel Manufacturers, and the committee announced its purpose of giving further consideration to this important question. Accordingly, the matter was referred to Sub-Committees II on Structural Steel for Bridges, Buildings and Rolling Stock, III on Structural Steel for Ships, and XI on Boiler Steels. These sub-committees appointed a sub-sub-committee consisting of three producers (who are members of The Association of American Steel Manufacturers) and three non-producers, under the chairmanship of Mr. S. T.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 23 (1913).
[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 100 (1914).

Wagner, Chairman of Sub-Committee II, with instructions to report tables of permissible variations for the consideration of the sub-committees. The sub-sub-committee has held three meetings, at which data involving many thousands of plates were presented in both tabular and graphical form, and has cooperated with the manufacturers through their representatives on the sub-sub-committee. After careful consideration, the sub-sub-committee was unable to make unanimous recommendations, but has submitted a report of substantial progress.

Committee A-1 presents the above as a progress report, and will continue its consideration of the question in cooperation with The Association of American Steel Manufacturers.

MISCELLANEOUS ANNOUNCEMENTS.

In addition to questions now under consideration and previously referred to, the following new matters will be taken up during the year by the committee through the appropriate sub-committees:

Sub-Committee I.—Specifications for Screw Spikes, Tie Plates and Ties.

Sub-Committee IV.—Specifications for Springs for Automobiles.

Sub-Committee XIII.—Standard holders for 2-in. tension test specimens.

This report has been submitted to letter ballot of the committee, which consists of 96 members, of whom 57 have voted affirmatively, 5 negatively, and 34 have refrained from voting.

Respectfully submitted on behalf of the committee,

C. D. YOUNG,
Chairman.

C. L. WARWICK,
Secretary.

[EDITOR'S NOTE.—In presenting this report at the annual meeting, Committee A-1 recommended certain amendments,

which are given on page 17. For action taken on the report as amended, see pages 16–19.

The proposed amendments in the Standards referred to on page 79, as amended at the annual meeting, and the six proposed Standards referred to on pages 79–80, as amended at the annual meeting, were adopted by letter ballot of the Society on August 21, 1915. The Standards as thus amended appear among the Standards in the 1915 Year-Book.

The proposed Tentative Standards referred to on page 80, as amended at the annual meeting, appear among the Tentative Standards in the 1915 Year-Book.

For Discussion on the report, see page 115.]

APPENDIX I.

REPORT ON FINISHING TEMPERATURES OF RAILS.

SUBMITTED BY SUB-COMMITTEE I, ON STEEL RAILS AND ACCESSORIES, OF COMMITTEE A-1.

MR. C. D. YOUNG, *Chairman*,
Committee A-1, A. S. T. M.

Dear Sir:

In a recent paper by Messrs. G. K. Burgess, J. J. Crowe, H. S. Rawdon and R. G. Waltenburg, which was issued by the Bureau of Standards under the title "Observations on Finishing Temperatures and Properties of Rails," the Standard Specifications for Steel Rails adopted by the American Society for Testing Materials are criticised as follows:

1. In a general condemnation of the use of shrinkage allowance as the basis of temperature determination.

2. In that the shrinkage permitted is too great.

Sub-Committee I, on Steel Rails and Accessories, of Committee A-1 has taken these criticisms under consideration, and presents herewith its report:

Shrinkage Allowance vs. Pyrometer Control.—Theoretically the determination of the finishing temperature of a bar of steel, because of the sensitiveness of the measuring apparatus, should be much more exact than measuring the variation in the change of length of a bar in cooling. There are, however, two reasons why the cruder means is preferable.

1. It is much easier to enforce. The mill must set the saws at such a distance apart in the case of gang saws, or at such distance from the stop in the case of a single saw, that when rails are cold they will be within the close tolerances for length prescribed by the specifications. The penalty for not observing this is the milling of every rail to length, and the penalty is so severe in a modern rail mill that there is no question that the proper adjustment of the hot length will be provided. It is

not possible for the mill to manipulate the hot length without the knowledge of the inspector, who can without difficulty satisfy himself that any shrinkage-allowance requirements are being observed. The measurement of temperatures of rails by pyrometer is a much more complicated proposition. Carrying the identity of each hot rail as to its observed temperature through the mill and out to the finishing shed where it can be rejected where necessary, would be a difficult and expensive procedure. One or two men would be required to operate the pyrometer and record temperatures, and several men would probably be required to follow up those rails which showed temperatures outside of the limits permitted.

2. The pyrometer measures the temperature at the particular portion of the bar that is under observation. For a simple section this does not vary greatly, but in a complex section, like a tee rail, there is a wide variation in the temperature of the various parts. The records of measured temperatures given in the Bureau of Standards' paper refer to observations made on the head or at the center of the base. If limiting temperatures were specified, and these temperatures were observed on the head or the center of the base, it is quite possible that with the section of the thin-base type, the edges of the flange might be rolled at a temperature below the recalescence. The reduction in the rail-mill passes is likely to damage high-carbon steel at this low temperature.

The Amount of Shrinkage.—The authors of the paper have taken the maximum shrinkage allowed in the specifications of the Society, and by dividing by the coefficient of shrinkage established by their experiments, have arrived at a temperature which they claim could be used in rolling rails, and yet keep within the requirements of the specifications. Such a method of arriving at rolling temperatures is not admissible in the case of unbalanced sections. The shrinkage allowance necessary for rails is a function, not only of the average temperature, but also of the section. The flanges of a thin-base section cool much more rapidly than the other parts of the section, and in cooling first, they become more rigid than the remainder of the section. When cut by the saws the cooler base and hotter head are of the same length, but as the head has a greater range to

cool through, its shrinkage would be greater and cold length less than the base. This is corrected by the cambering rolls, which stretch the head to such length as will compensate for its greater shrinkage.

The shrinkage allowance necessary for any rail is not the shrinkage allowance based on the average temperature of the rail, nor the temperature of the head or base, such as observed in the Bureau of Standards' experiments; but the shrinkage allowance in sawing, which is necessary for any rail, is the amount of shrinkage of the portion which cools and becomes rigid first.

In view of the importance of the subject, it seems very desirable to secure some data as to the effect of the variation in the finishing temperature on the quality of the rail. While there is a large amount of literature bearing on the subject, actual dependable data regarding the quality of the rails are very scarce. Mr. M. H. Wickhorst reported on a series of tests made on Bessemer rails, the finishing temperatures of which measured on the heads varied from 940 to 1030° C., and more recently the same investigator reported on a similar series of tests made on open-hearth rails. The rails were subjected to drop tests, bend tests, tension tests, transverse tests of base, and the structure was examined under the microscope.

As a result of the tests on Bessemer steel rails, Mr. Wickhorst reported "that the ductility and deflection in the drop test were influenced little, if any, by the temperature. The number of blows that it took to break the rails in the drop test was uninfluenced by the temperature of rolling. The yield point and tensile strength in the tension tests were influenced little, if any. The elongation in the tension test decreased some as the temperature increased. The influence of temperature showed most prominently in the tension test, in the reduction of area, which decreased as the temperature of rolling increased. The size of the grain, as shown by the microscope, increased as the temperature increased."

His conclusions on the open-hearth series, which were rolled at temperatures between 695 and 850° C., were as follows:

"It may be said that the results in the drop tests, slow bending tests and transverse tests of the base, were about the

same for the different finishing temperatures, varied by holding the rail bar between rolls before final finishing. In the tensile tests the results were also about the same, except that the lower finishing temperatures showed a little greater elongation and reduction of area. The lower finishing temperatures also showed a somewhat finer grain structure."

Sub-Committee I has made an effort to obtain some more data on the subject and has tried to get some actual figures regarding the effect on the service of the rails in track, but on the latter point, nothing other than general statements have been obtained. We are, however, able to submit the results of investigation of the physical properties of the rails finished at various temperatures, as determined by drop tests, ductility tests, tension tests, fatigue flexure tests, and abrasion tests. The work was done by the Illinois Steel Co., the Pennsylvania Steel Co. and the Cambria Steel Co.

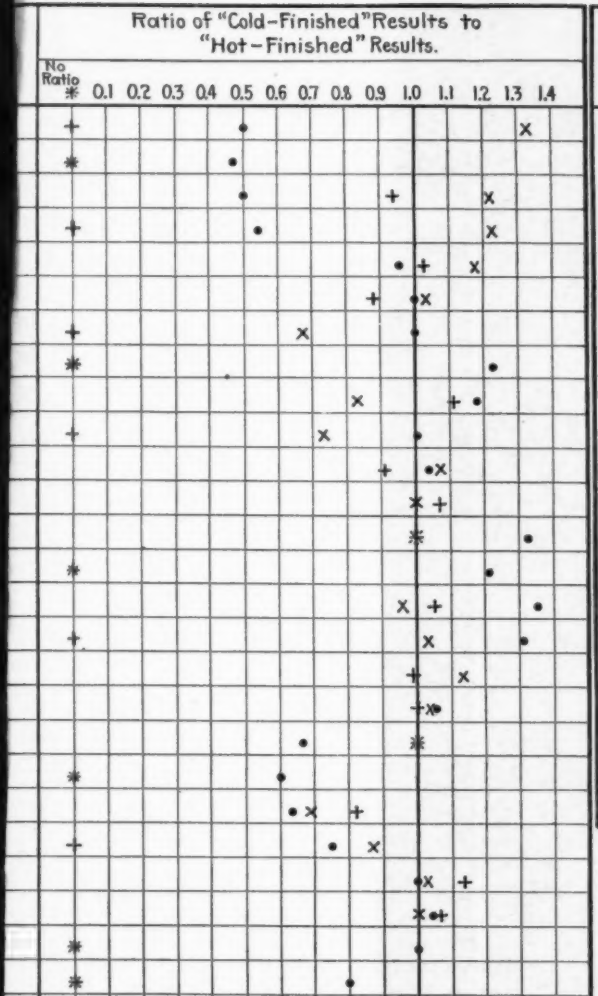
RESULTS OF PHYSICAL TESTS.

Tests made by Illinois Steel Co.—Three heats of steel were used, one being rolled into 85-lb. rails, one into 90-lb. rails and one into 100-lb. rails, all of the A. R. A. section, type "A." Part of the rails were rolled at a temperature corresponding to a shrinkage of $6\frac{3}{4}$ in. for the 100-lb., 33-ft. rails, and part were rolled at a temperature corresponding to a shrinkage of $5\frac{9}{16}$ in. for 100-lb., 33-ft. rails. Those finished at the higher temperature are marked "hot-finish," and those at the lower temperature, "cold-finish" in the test records which are given in detail in Tables I to XIV, inclusive. The finishing temperatures close to the edge of the flange varied from 880 to 905° C. on the hot-finished rails, and from 740 to 760° C. on the cold-finished rails. These temperatures were measured at the finishing pass in the rail mill, and are only 50 to 70° C. above the critical temperature for rail steel, and were therefore as low as it was deemed advisable to go.

In order to show graphically the relation between the results obtained on hot-finished and cold-finished series, the results have been plotted and are shown in Figs. 1 and 2 (Plates I and II). In every case the results obtained on the "hot-finished" rails are taken at unity, while the ratio of the "cold-finished"

Rail	Property	Ratio of "Cold-Finished" Re "Hot-Finished" Res No Ratio * 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
A	Number of Blows without Fracture	+ •
	Maximum Elongation in 1"	* •
	Total Elongation in 6"	• +
	Permanent Set	+ •
	Elongation after First Blow	
	Permanent Set " " "	+
B	Number of Blows without Fracture	+ ×
	Maximum Elongation in 1"	*
	Total Elongation in 6"	×
	Permanent Set	+ ×
	Elongation after First Blow	
	Permanent Set " " "	
C	Number of Blows without Fracture	
	Maximum Elongation in 1"	*
	Total Elongation in 6"	
	Permanent Set	+
	Elongation after First Blow	
	Permanent Set " " "	
D	Number of Blows without Fracture	•
	Maximum Elongation in 1"	* •
	Total Elongation in 6"	• × +
	Permanent Set	+ • ×
	Elongation after First Blow	
	Permanent Set " " "	
E	Number of Blows without Fracture	*
	Maximum Elongation in 1"	* •
	Total Elongation in 6"	×
	Permanent Set	+ ×
	Elongation after First Blow	+
	Permanent Set " " "	+

FIG



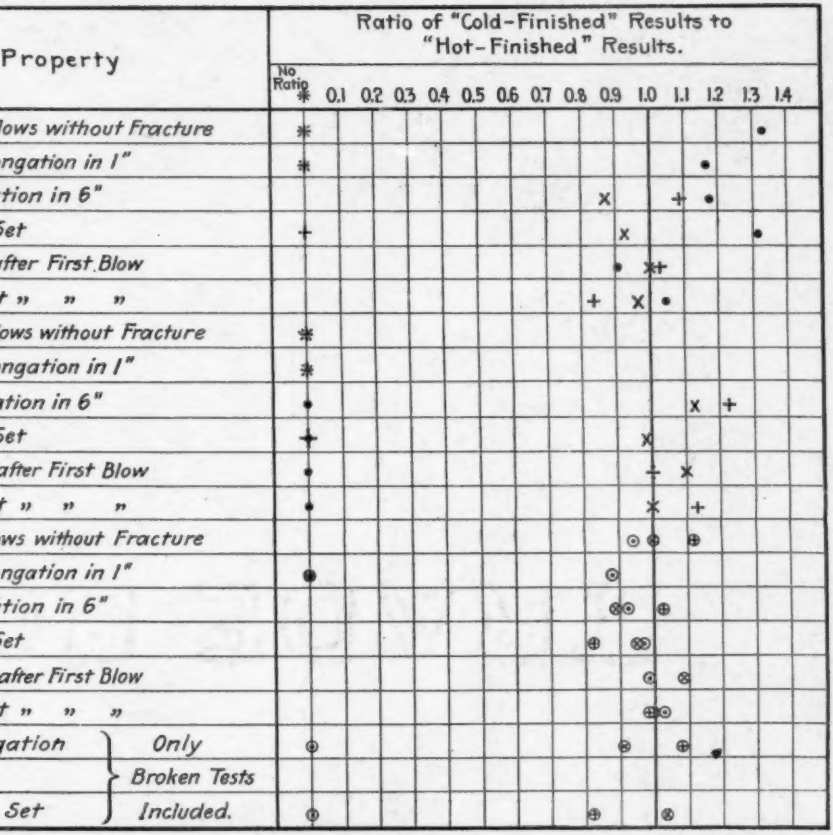
Rail	Proper
F	Number of Blows with
	Maximum Elongation
	Total Elongation in 6
	Permanent Set
	Elongation after Firs
	Permanent Set » »
G	Number of Blows with
	Maximum Elongation
	Total Elongation in 6
	Permanent Set
	Elongation after Firs
	Permanent Set » »
Average of Rails of all Letters	Number of Blows with
	Maximum Elongation
	Total Elongation in
	Permanent Set
	Elongation after Firs
	Permanent Set » »
	Total Elongation in 6"
	Permanent Set

* No R

H
4
4
4

FIG. 1.—Ductility and Elongation Tests of Rails.

PLATE I.
PROC. AM. SOC. TEST. MATS.
VOL. XV, PART I.
REPORT OF COMMITTEE A-1:
DUCTILITY AND ELONGATION TESTS OF RAILS.



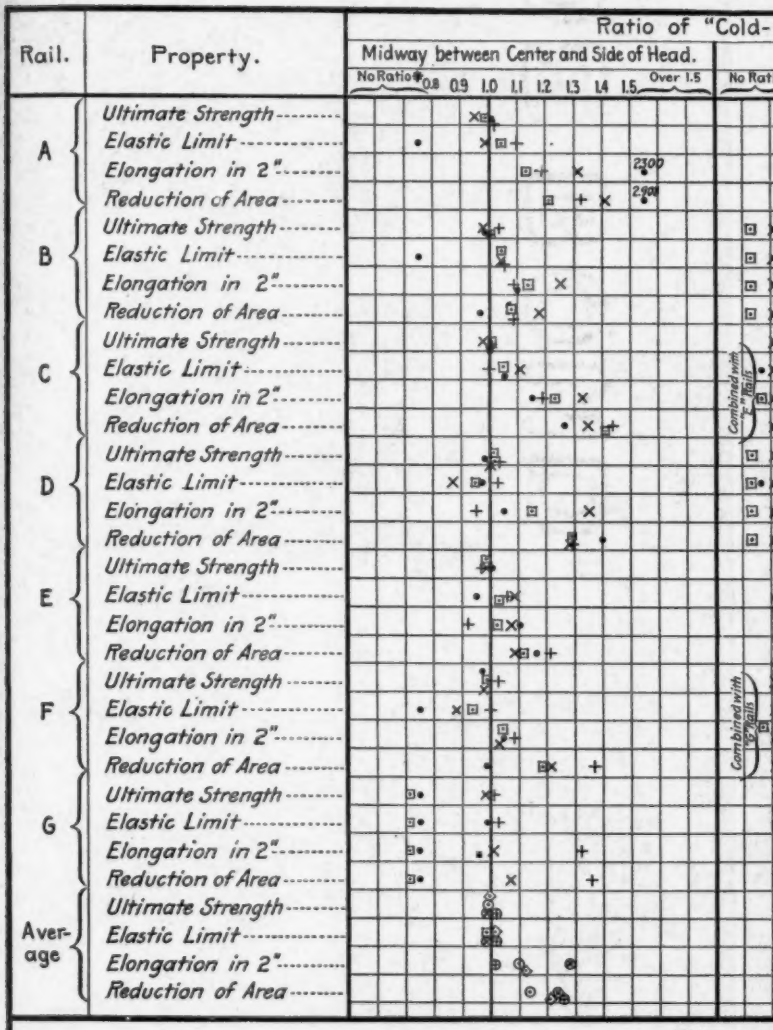
* No Ratio, Due to Absence of Result for either Hot or Cold Test, or Both.

— KEY TO POINTS —

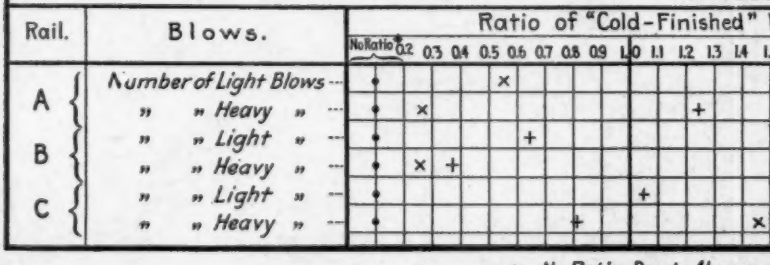
Heat	Weight	Single	Average
47 330	85	+	⊕
45 164	90	×	⊗
46 216	100	•	⊙

ls.

TENSION



FATIGUE



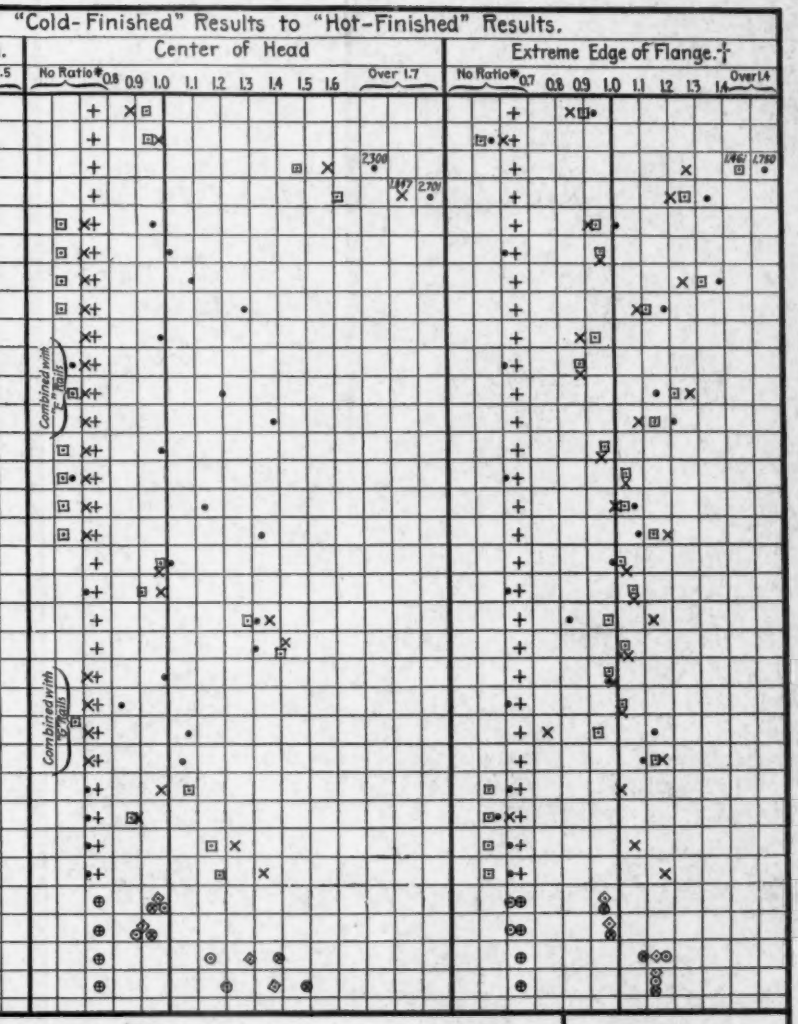
* No Ratio, Due to Absence o

† The Elongation of Specimens from

FIG. 2.—Tension and Fat

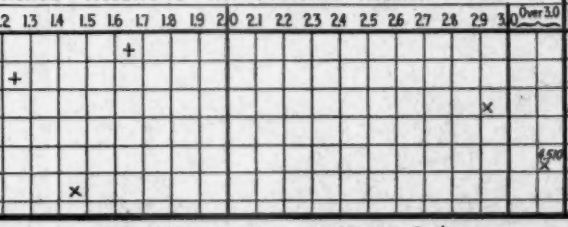
TENSION TESTS.

"Cold-Finished" Results to "Hot-Finished" Results.


Center of Head
No Ratio* 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 Over 1.7
Extreme Edge of Flange.†
No Ratio* 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 Over 1.4
2.300
1.147
2.701
1.461
1.760
Combined with 7" Rails
Combined with 10" Rails

FATIGUE TESTS.

"Hot-Finished" Results to "Hot-Finished" Results.



KEY TO POINTS

Weight/Yard	85 lb.	90 lb.	100 lb.
Heat No.	47330	45164	46216
Single Test	+	×	•
Ave. "A" to "G"	⊕	●	⊙
Ave. for All 3 Sections			⊡
" " " " " and All Letters "A" to "G" incl.			◈

* Absence of Result for either Hot or Cold Test, or Both.
† Specimens from the Extreme Edge of Flange was Measured in 1-in

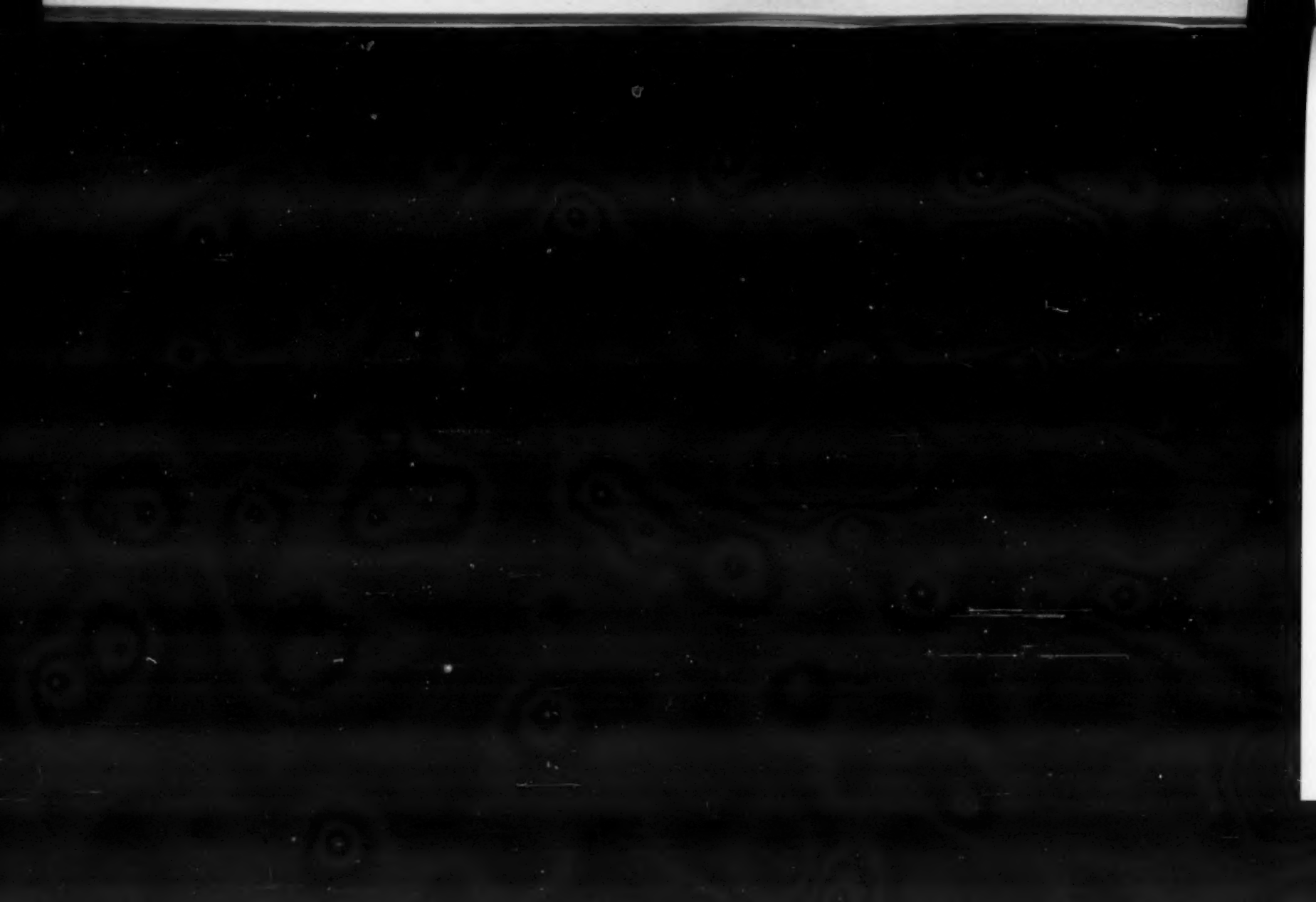


TABLE I.—DUCTILITY AND ELONGATION TESTS; HEAT NO. 47,330; SECTION NO. 8520.

WEIGHT OF TUP, 2000 LB.; HEIGHT OF DROP, 17 FT.; SUPPORTS, 36 IN. CENTER TO CENTER.
ALL TEST SPECIMENS STRUCK ON HEAD; SEVEN RAILS TESTED.

	"A" Rails.		"B" Rails.		"C" Rails.		"D" Rails.		"E" Rails.		"F" Rails.		"G" Rails.		Average of all Rails.	
	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish
Number of blows without fracture	....	2	2	....	3	3	3	3	2	....	....	3	....	3	2.5[a]	2.8[b]
Total elongation in 6 in., in	0.51	0.48	0.45	0.50	0.54	0.57	0.57	0.47	0.45	0.43	0.55	0.60	0.47	0.58	0.506	0.519
Permanent set, in	....	3.0	3.1	....	....	....	4.6	....	3.2	....	....	....	....	....	3.63[c]	3.0[d]
Elongation after first blow, in	0.35	0.36	0.33	0.30	0.30	0.28	0.29	0.33	0.31	0.27	0.32	0.33	0.32	0.32	0.317	0.313
Permanent set after first blow, in	1.7	1.5	1.5	1.6	1.6	1.6	1.5	1.6	1.7	1.5	1.9	1.6	1.5	1.7	1.63	1.59
Remarks	Bent out of shape	None	None	Bent out of shape	Bent out of shape before breaking	Bent out of shape before breaking	None	Bent out of shape before breaking	None	Bent out of shape	Bent out of shape	Bent out of shape before breaking	Bent out of shape	Bent out of shape before breaking	....	....

[a] Four rails.
[b] Five rails.
[c] Three rails
[d] One rail.

NOTE.—Average total elongation in 6 in., including tests which were not broken: Hot-finished, 0.503 in. (4 rails); cold-finished, 0.540 in. (5 rails).
Average permanent set, including tests which were not broken: Hot-finished, 3.63 in. (3 rails); cold-finished, 3.0 in. (1 rail).

TABLE II.—DUCTILITY AND ELONGATION TESTS; HEAT NO. 45,164; SECTION NO. 9020.

WEIGHT OF TUP, 2000 LB.; HEIGHT OF DROP, 17 FT.; SUPPORTS, 36 IN. CENTER TO CENTER.
ALL TEST SPECIMENS STRUCK ON HEAD; SEVEN RAILS TESTED.

	"A" Rails.		"B" Rails.		"C" Rails.		"D" Rails.		"E" Rails.		"F" Rails.		"G" Rails.		Average of all Rails.	
	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.
Number of blows without fracture	3	4	3	2	3	3	3	3	3	....	3	....	....	3	3.00[a]	3.00[a]
Total elongation in 6 in., in	0.69	0.84	0.68	0.56	0.76	0.73	0.78	0.54	0.85	0.67	0.77	0.67	0.64	0.72	0.739	0.657
Permanent set, in	3.30	4.05	3.40	2.50	3.40	3.50	3.35	2.90	3.50	3.05	3.30	3.05	3.20	3.15	3.350[a]	3.207[a]
Elongation after first blow, in	0.28	0.33	0.29	0.31	0.29	0.33	0.30	0.31	0.30	0.33	0.31	0.31	0.31	0.34	0.297	0.323
Permanent set after first blow, in	1.35	1.40	1.35	1.35	1.30	1.35	1.35	1.35	1.40	1.35	1.40	1.35	1.35	1.35	1.357	1.357
Remarks	None	None	Bent out of shape	Broke on support	None	None	None	None	None	Bent out of shape	None	Bent out of shape	Bent out of shape	Broke over supports	....	....

[a] Five rails.

NOTE.—Average total elongation in 6 in., not including specimens breaking over supports or bent out of shape: Hot-finished, 0.770 in. (5 rails); cold-finished, 0.703 in. (3 rails).

Average permanent set, not including tests breaking over supports or bent out of shape: Hot-finished, 3.370 in. (5 rails); cold-finished, 3.483 in. (3 rails).

TABLE III.—DUCTILITY AND ELONGATION TESTS; HEAT NO. 46,216; SECTION NO. 10,020.

WEIGHT OF TUP, 2000 LB.; HEIGHT OF DROP, 17 FT.; SUPPORTS, 36 IN. CENTER TO CENTER.
ALL TEST SPECIMENS STRUCK ON HEAD; SIX RAILS TESTED.

	"A" Rails.		"B" Rails.		"C" Rails.		"D" Rails.		"E" Rails.		"F" Rails.		Average of all Rails.	
	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.
Number of blows without fracture	4	2	4	4	3	4	3	2	2	2	3	4	3.17	3.00
Total elongation in 6 in., in	0.80	0.40	0.61	0.72	0.59	0.80	0.71	0.44	0.42	0.42	0.55	0.66	0.613	0.573
Maximum elongation in 1 in., in	0.19	0.09	0.13	0.16	0.14	0.17	0.15	0.09	0.10	0.08	0.12	0.14	0.138	0.122
Permanent set, in	3.10	1.70	3.20	3.20	2.45	3.20	2.40	1.80	1.85	1.90	2.50	3.30	2.58	2.51
Elongation after first blow, in	0.22	0.21	0.22	0.23	0.22	0.22	0.22	0.22	0.23	0.23	0.21	0.19	2.20	2.17
Permanent set after first blow, in	1.00	1.00	1.00	1.05	1.00	1.05	1.00	1.05	1.05	1.05	1.00	1.05	1.008	1.041
Remarks	None	None	None	None	None	None	None	None	None	None	None	None	....	....

NOTE.—No specimens either broke over supports or bent out of shape.

TABLE IV.—RECORD OF TENSION TESTS; HEAT NO. 47,330; SECTION NO. 8520.

DATE OF TEST, AUGUST 5, 1914.
LOCATION OF TEST SPECIMENS, MIDWAY BETWEEN CENTER AND SIDE OF HEAD.
TIME BETWEEN ROLLING AND TESTING, 8 DAYS.
DIAMETER OF TEST SPECIMENS, ½ IN.
GAGE LENGTH OF TEST SPECIMENS, 2 IN.

HOT-FINISHED RAILS, SPECIMEN NO. 653.

Properties Considered.	"A" Rails.	"B" Rails.	"C" Rails.	"D" Rails.	"E" Rails.	"F" Rails.	"G" Rails.	Average.
Ultimate strength, lb. per sq. in.	107 530	108 750	112 180	110 930	112 760	108 780	107 450	109 770
Elastic Limit, lb. per sq. in.	60 440	56 450	58 150	56 870	57 150	58 500	57 750	57 900
Elongation in 2 in., per cent.	10.50	11.00	10.50	11.00	11.50	11.50	11.00	11.00
Reduction of area, per cent.	13.39	15 59	13.08	13.73	13.18	14.48	14.88	14.33
Fracture.	Granular	Granular	Granular	Granular	Granular	Granular	Granular	.....

COLD-FINISHED RAILS, SPECIMEN NO. 654.

Ultimate strength, lb. per sq. in.	109 200	112 900	112 690	114 900	110 740	111 740	109 450	111 515
Elastic limit, lb. per sq. in.	66 440	59 450	57 950	58 550	60 700	58 450	59 350	60 125
Elongation in 2 in., per cent.	12.50	12.00	12.50	10.50	10.50	12.50	14.50	12.14
Reduction of area, per cent.	17.73	17.00	18.80	17.73	15.94	19.82	20.30	18.19
Fracture.	Granular	Granular	Granular	Granular	Granular	Granular	Granular	.....

TABLE V.—RECORD OF TENSION TESTS; HEAT NO. 45,164; SECTION NO. 9020.

DATE OF TEST, JULY 31, 1914.
LOCATION OF TEST SPECIMENS, MIDWAY BETWEEN CENTER AND SIDE OF HEAD.
TIME BETWEEN ROLLING AND TESTING, 8 DAYS.
DIAMETER OF TEST SPECIMENS, ½ IN.
GAGE LENGTH OF TEST SPECIMENS, 2 IN.

HOT-FINISHED RAILS, SPECIMEN NO. 650.

Properties Considered.	"A" Rails.	"B" Rails.	"C" Rails.	"D" Rails.	"E" Rails.	"F" Rails.	"G" Rails.	Average.
Ultimate strength, lb. per sq. in.	110 600	112 640	113 530	112 020	112 080	112 770	112 080	112 245
Elastic limit, lb. per sq. in.	57 220	58 140	58 200	68 310	57 720	69 820	59 600	61 285
Elongation in 2 in., per cent.	16.00	12.00	12.00	14.00	14.00	14.50	16.00	14.07
Reduction of area, per cent.	20.90	16.27	14.49	19.16	17.74	16.97	22.69	18.32
Fracture.	Granular	Granular	Granular	Granular	Granular	Granular	Granular	.....

COLD-FINISHED RAILS, SPECIMEN NO. 651.

Ultimate strength, lb. per sq. in.	105 450	110 020	111 200	111 790	111 300	110 660	111 390	110 260
Elastic limit, lb. per sq. in.	56 500	60 740	64 330	59 400	63 090	61 440	59 210	60 675
Elongation in 2 in., per cent.	21.00	15.00	16.00	19.00	15.00	15.00	16.00	16.70
Reduction of area, per cent.	29.46	19.18	21.94	24.77	19.50	20.58	24.38	22.83
Fracture.	Granular	Granular	Granular	Granular	Granular	Granular	Granular	.....

TABLE VI.—RECORD OF TENSION TESTS; HEAT NO. 46,216; SECTION NO. 10,020.

DATE OF TEST, SEPTEMBER 26, 1914.
LOCATION OF TEST SPECIMENS, MIDWAY BETWEEN CENTER AND SIDE OF HEAD.
TIME BETWEEN ROLLING AND TESTING, 8 DAYS.
DIAMETER OF TEST SPECIMENS, ½ IN.
GAGE LENGTH OF TEST SPECIMENS, 2 IN.

HOT-FINISHED RAILS, SPECIMEN NO. 671.

Properties Considered.	"A" Rails.	"B" Rails.	"C" Rails.	"D" Rails.	"E" Rails.	"F" Rails.	Average
Ultimate strength, lb. per sq. in.	118 400	117 750	123 100	120 400	118 800	121 300	119 960
Elastic limit, lb. per sq. in.	.....	.....	65 160	62 660	62 660	.....	63 490
Elongation in 2 in., per cent	5.00[a]	10.00	9.50	10.00	10.00	11.00	10.10
Reduction of area, per cent	5.12[a]	13.78	12.28	11.92	13.04	15.99	13.40
Fracture	Granular	Granular	Granular	Granular	Granular	Granular	.....

[a] Test specimen broke in shoulder, not included in averages.

COLD-FINISHED RAILS, SPECIMEN NO. 672.

Ultimate strength, lb. per sq. in.	119 200	116 450	121 200	119 290	119 300	118 650	119 015
Elastic limit, lb. per sq. in.	.....	.....	68 810	60 640	59 690	60 920	62 515
Elongation in 2 in., per cent	11.50	11.00	11.00	10.50	11.00	11.50	11.10
Reduction of area, per cent	14.89	13.33	15.59	16.70	15.18	15.90	15.27
Fracture	.....	.....	.....	.....	.....	.....	.....

TABLE VII.—RECORD OF TENSION TESTS; HEAT NO. 45,164; SECTION NO. 9020.

DATE OF TEST, SEPTEMBER 3, 1914.
LOCATION OF TEST SPECIMENS, CENTER OF HEAD.

TIME BETWEEN ROLLING AND TESTING, 43 DAYS.
DIAMETER OF TEST SPECIMENS, ½ IN.
GAGE LENGTH OF TEST SPECIMENS, 2 IN.

HOT-FINISHED RAILS, SPECIMEN NO. 650.

Properties Considered.	"A" Rails.	"E" Rails.	"G" Rails.	Average.
Ultimate strength, lb. per sq. in.	116 850	113 900	108 680	113 145
Elastic limit, lb. per sq. in.	78 700	80 200	82 280	80 395
Elongation in 2 in., per cent.	9.00	11.00	13.00	11.00
Reduction of area, per cent	10.83	15.30	17.86	14.66
Fracture	Granular	Granular	Granular	.....

COLD-FINISHED RAILS, SPECIMEN NO. 651.

Ultimate strength, lb. per sq. in.	102 970	110 560	106 000	106 510
Elastic limit, lb. per sq. in.	74 580	78 240	72 930	75 250
Elongation in 2 in., per cent.	15.00	15.00	16.00	15.33
Reduction of area, per cent.	20.00	21.70	23.80	21.83
Fracture	Granular	Granular	Granular	.....

TABLE VIII.—RECORD OF TENSION TESTS; HEAT NO. 46,216; SECTION NO. 10,020.

DATE OF TEST, OCTOBER 2, 1914.
LOCATION OF TEST SPECIMENS, CENTER OF HEAD.
(SEE TABLE VII.)

TIME BETWEEN ROLLING AND TESTING, 14 DAYS.
DIAMETER OF TEST SPECIMENS, ½ IN.
GAGE LENGTH OF TEST SPECIMENS, 2 IN.

HOT-FINISHED RAILS, SPECIMEN NO. 671.

Properties Considered.	"A" Rails.	"B" Rails.	"C" Rails.	"D" Rails.	"E" Rails.	"F" Rails.	Average.
Ultimate strength, lb. per sq. in.	128 300	127 000	123 800	118 000	114 200	119 650	121 825
Elastic limit, lb. per sq. in.	79 720	72 430	.....	.....	.....	71 280	74 480
Elongation in 2 in., per cent.	5.00[a]	10.00	10.00	11.00	11.00	13.00	11.00
Reduction of area, per cent.	5.52[a]	13.10	13.10	14.90	18.20	21.36	16.13
Fracture.	Granular	Granular	Granular	Granular	Granular	Granular	.....

[a] Test specimens broke in shoulder, not included in averages.

COLD-FINISHED RAILS, SPECIMEN NO. 672.

Ultimate strength, lb. per sq. in.	127 000	121 200	121 540	116 700	115 780	119 050	120 210
Elastic limit, lb. per sq. in.	74 680	73 440	66 920	58 350	64 980	59 860	66 370
Elongation in 2 in., per cent.	11.50	11.00	12.00	12.50	14.50	14.00	12.58
Reduction of area, per cent.	14.90	16.76	18.17	19.95	23.82	22.40	19.33
Fracture.	Granular	Granular	Granular	Granular	Granular	Granular	.....

TABLE IX.—RECORD OF TENSION TESTS; HEAT NO. 45,164; SECTION NO. 9020.

DATE OF TEST, AUGUST 13, 1914.
LOCATION OF TEST SPECIMENS, EXTREME EDGE OF FLANGE.
TIME BETWEEN ROLLING AND TESTING, 22 DAYS.
DIAMETER OF TEST SPECIMENS, ½ IN.
GAGE LENGTH OF TEST SPECIMENS, 1 IN.

HOT-FINISHED RAILS, SPECIMEN NO. 650.

Properties Considered.	"A" Rails.	"B" Rails.	"C" Rails.	"D" Rails.	"E" Rails.	"F" Rails.	"G" Rails.	Average.
Ultimate strength, lb. per sq. in.	118 480	123 330	127 340	120 200	113 300	113 900	117 550	119 160
Elastic limit, lb. per sq. in.	.....	68 230	76 800	67 360	61 760	64 590	.....	67 750
Elongation in 1 in., per cent.	15.00	14.00	15.00	18.00	15.00	16.00	17.00	15.70
Reduction of area, per cent.	28.80	31.11	30.56	29.90	30.56	30.78	31.11	30.40
Fracture	80 per cent silky	90 per cent silky	95 per cent silky	95 per cent silky	95 per cent silky	95 per cent silky	95 per cent silky	.....

COLD-FINISHED RAILS, SPECIMEN NO. 651.

Ultimate strength, lb. per sq. in.	101 300	112 050	112 600	114 700	117 680	111 850	117 750	112 560
Elastic limit, lb. per sq. in.	61 690	65 310	67 860	69 310	65 490	65 390	66 330	65 910
Elongation in 1 in., per cent.	19.00	17.50	19.00	18.00	17.00	12.00	18.00	17.20
Reduction of area, per cent.	34.77	33.83	33.19	35.50	31.77	35.62	36.26	34.42
Fracture	95 per cent silky	95 per cent silky	100 per cent silky	80 per cent silky	95 per cent silky	95 per cent silky	95 per cent silky	.....

TABLE X.—RECORD OF TENSION TESTS; HEAT NUMBER 46,216; SECTION NO. 10,020.

DATE OF TEST, OCTOBER 9, 1914.
LOCATION OF TEST SPECIMENS, EXTREME EDGE OF FLANGE.

TIME BETWEEN ROLLING AND TESTING, 21 DAYS.
DIAMETER OF TEST SPECIMENS, ½ IN.
GAGE LENGTH OF TEST SPECIMENS, 1 IN.

HOT-FINISHED RAILS, SPECIMEN NO. 671.

Properties Considered.	"A" Rails.	"B" Rails.	"C" Rails.	"D" Rails.	"E" Rails.	"F" Rails.	Average.
Ultimate strength, lb. per sq. in	127 280	128 230	123 100	127 110	122 100	124 790	125 435
Elastic limit, lb. per sq. in	.....	.....	.....	.....	.....	.....	.....
Elongation in 1 in., per cent	10.00	13.00	13.00	14.00	18.00	15.00	13.83
Reduction of area, per cent	18.73	23.78	23.01	27.32	25.96	25.26	24.01

COLD-FINISHED RAILS, SPECIMEN NO. 672.

Ultimate strength, lb. per sq. in	119 700	124 370	123 030	123 060	122 000	120 990	.....
Elastic limit, lb. per sq. in	.....	.....	.....	.....	.....	.....	.....
Elongation in 1 in., per cent	17.50	18.00	15.00	15.00	15.00	17.00	16.25
Reduction of area, per cent	25.16	27.32	27.89	29.44	26.14	27.45	27.23

TABLE XI.—AVERAGE RESULTS OF TENSION TESTS.

LOCATION OF TESTS, MIDWAY BETWEEN CENTER AND SIDE OF HEAD. SECTIONS 8520, 9020 AND 10,020.

Properties Considered.	"A" Rails.		"B" Rails.		"C" Rails.		"D" Rails.		"E" Rails.		"F" Rails.		Average of "A" to "F" Rails.	
	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.
Ultimate strength, lb. per sq. in.....	112 177	111 283	113 047	113 123	116 270	115 030	114 450	115 327	114 547	113 780	114 283	113 683	114 129	113 704
Elastic limit, lb. per sq. in.....	58 830	61 470	57 295	60 095	60 503	63 697	62 613	59 530	59 177	61 160	64 160	60 270	60 429	61 037
Elongation in 2 in., per cent.....	13.25[a]	15.00	11.00	12.67	10.67	13.17	11.67	13.33	11.83	12.17	12.33	13.00	11.79	13.22
Reduction of area, per cent.....	17.15[a]	20.69	15.21	16.50	13.28	18.78	14.94	19.40	15.32	16.87	15.81	18.77	15.29	18.50

[a] Section No. 10,020, which broke in shoulder, not included.
("C" rails which are not produced on 10,020 are omitted).

LADLE ANALYSIS.

Heat No.	Section No.	Percentage of				
		C.	Mn.	P.	S.	Si.
47 330	8 520	0.60	0.78	0.023	0.044	0.020
45 164	9 020	0.62	0.67	0.018	0.038	0.014
46 216	10 020	0.70	0.74	0.026	0.041	0.014

TABLE XII.—AVERAGE RESULTS OF TENSION TESTS.

LOCATION OF TESTS, CENTER OF HEAD. SECTIONS NOS. 9020 AND 10,020.

Properties Considered.	"A" Rails.		"C" Rails, Section No. 10,020; "E" Rails, Section No. 9020.		"F" Rails, Section No. 10,020; "G" Rails, Section No. 9020.		Average of the Three Rails.	
	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.
Ultimate strength, lb. per sq. in	122 575	114 985	118 850	116 050	114 165	112 525	118 530	114 520
Elastic limit, lb. per sq. in	79 210	74 630	80 200	72 580	76 780	66 395	78 730	71 202
Elongation in 2 in., per cent	9.00[a]	13.25	10.50	13.50	13.00	15.00	10.83	13.92
Reduction of area, per cent	10.83[a]	17.45	14.20	19.94	19.61	23.10	14.88	20.16

[a] Section 10,020 test specimen, which broke in shoulder, not included.

TABLE XIII.—AVERAGE RESULTS OF TENSION TESTS.

LOCATION OF TESTS, EXTREME EDGE OF FLANGE. SECTIONS NOS. 9020 AND 10020.

Properties Considered.	"A" Rails.		"B" Rails.		"C" Rails.		"D" Rails.		"E" Rails.		"F" Rails.		Average of "A" to "F" Rails.	
	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.	Hot-finish.	Cold-finish.
Ultimate strength, lb. per sq. in	122 880	110 500	125 780	118 210	125 220	117 815	123 655	118 880	117 700	119 840	119 345	116 420	122 430	116 944
Elastic limit, lb. per sq. in	.....	61 690	68 230	65 310	76 800	67 860	67 360	69 310	61 760	65 490	64 590	65 390	67 748	65 842
Elongation in 1 in., per cent	12.50	18.25	13.50	17.75	14.00	17.00	16.00	16.50	16.50	16.00	15.50	14.50	14.67	16.67
Reduction of area, per cent	23.77	29.97	27.45	30.58	26.79	30.54	28.61	32.47	28.26	28.96	28.02	31.54	27.15	30.68

results to the former are shown either to the right or to the left of the line representing unity, as the values are above or below the corresponding values for the "hot-finished" rails.

Figs. 1 and 2 (Plates I and II) show that in general there is no marked difference between the qualities of the rails rolled at these various temperatures. The drop tests on the 85-lb. rails would indicate that the rails finished at low temperatures have

TABLE XIV.—RECORD OF GAG TESTS.

Specimen No.	Heat No.	Letter of Rail.	Section No.	Blows.		Character of Fracture.	Finishing Temperature.
				Light.	Heavy.		
650-A	45164	A	9020	45 360	439	Moon Otherwise clear	High
650-B	45164	B	9020	28 870	451	"	"
650-C	45164	C	9020	27 700	559	Clear	"
651-A	45164	A	9020	25 280	117	Moon Otherwise clear	Low
651-B	45164	B	9020	84 452	117	Clear	"
651-C	45164	C	9020	124 844	816	Moon Otherwise clear	"
653-A	47330	A	8520	15 720	423	Moon Otherwise clear	High
653-B	47330	B	8520	15 040	411	"	"
653-C	47330	C	8520	18 275	496	"	"
654-A	47330	A	8520	25 900	527	"	Low
654-B	47330	B	8520	9 680	153	"	"
654-C	47330	C	8520	19 190	402	"	"

NOTE.—Light blows were adjusted to cause a deflection of approximately $\frac{1}{2}$ in., rail turned over after each 1000 blows.
Heavy blows were adjusted to cause a permanent set of approximately $\frac{1}{16}$ in., rail turned over after each blow.
Distance between supports, 20 in.
Rapidity of light blows, 40 per minute.

slightly better physical properties, but the reverse is indicated on the 90 and 100-lb. rails. The tension tests on 85-lb. rails also show slightly better properties in the rails finished at low temperatures, but the same test on the 90 and 100-lb. rails show decrease in both elastic limit and ultimate strength on the low-temperature rails; while the elongation and reduction of area are increased compared with the rails rolled at the higher temperature.

The fatigue tests show more uniformity in the rails finished at high temperature than those finished at low temperature.

Tests made by Pennsylvania Steel Co.—The Pennsylvania Steel Co. made tests to determine the relative resistance to abrasion of various rails under conditions approaching those

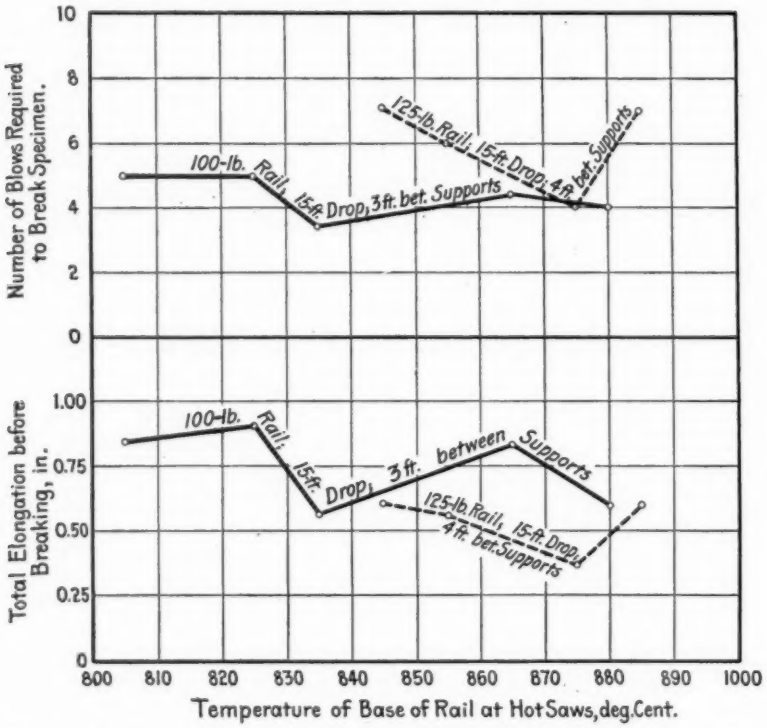


FIG. 3.—Tests on Pennsylvania Railroad Rails made by Cambria Steel Co.

existing in ordinary service. The machine used had a circular track with a revolving carriage equipped with standard wheels, with facilities for adjusting the wheel loads and the speed. The rails to be tested were laid in the track and the amount of metal worn away from the head was measured. Rails finished at temperatures of 850, 990 and 1090° C. were tested in the machine at the same time, and the amount of metal worn away was as follows:

FINISHING TEMPERATURE, DEG. CENT.	SHRINKAGE, IN.	AMOUNT OF WEAR, PER CENT.
850	6.4	67
990	7.3	64
1090	7.8	66

The amount of wear is practically uniform.

Tests made by Cambria Steel Co.—Tests were made on 100 and 125-lb. Pennsylvania Railroad rails, which were finished at various temperatures ranging between 805 and 885° C. The number of blows required to break the rail and the total percentage of elongation measured in the base, which the rail gave before fracture under the drop test, were used to indicate the comparative brittleness and ductility. The results are shown in Fig. 3 and indicate very little effect of the different finishing temperatures within the range of the experiment.

RESULTS OF SERVICE IN TRACK.

The behavior in track under service conditions is, of course, the ultimate test as to the quality of rails, but there appears to be very little data available to connect the service given by rails with their finishing temperatures. As general information we submit the following statements by Mr. J. B. Young, Chemist of the Philadelphia & Reading Railway Co., and Mr. J. Craig Crawford, Assistant Engineer of the Pennsylvania Railroad Co.

Mr. Young writes as follows:

"I give below the shrinkage obtained at five mills on both our standard 100-lb. section and the 90-lb. A. S. C. E. sections:

MILL.	SECTION.	SHRINKAGE, IN.
A[1]	90-lb. A. S. C. E.	$6\frac{5}{8}$
A[1]	100-lb. P. & R. Standard	$6\frac{3}{4}$
B[3]	90-lb. A. S. C. E.	$6\frac{1}{2}$
C[3]	90-lb. A. S. C. E.[1]	$6\frac{5}{8}$
C[3]	90-lb. A. S. C. E.[2]	$6\frac{3}{4}$
C[3]	100-lb. P. & R. Standard[1]	7
D[3]	90-lb. A. S. C. E.	6 to $6\frac{1}{2}$
D[3]	100-lb. P. & R. Standard	$6\frac{1}{2}$
E[3]	90-lb. A. S. C. E.	$6\frac{5}{8}$ to $6\frac{3}{4}$
E[3]	100-lb. P. & R. Standard	$6\frac{3}{4}$ to $7\frac{1}{4}$

[1] Bessemer.
[2] Open-hearth.
[3] Bessemer and open-hearth.

"The results of service records show that the 90-lb. rails from mill A gave very poor service in the track. The 100-lb. rails from this mill gave varying service, but none of it was more than fair and most of it poor.

"The rails from mill B, both Bessemer and open hearth, gave poor service.

"The 90-lb. Bessemer and open-hearth rails from mill C gave good service, the service of the open-hearth rails being exceptionally good. The 100-lb. rail from mill C was all Bessemer and has given very good service for Bessemer rail.

"The 90-lb. rail from mill D which was finished with a 6-in. shrinkage was poor. The rail that did not fail is giving good service as to wear, but the failures per 10,000 tons are high. The 90-lb. rail from this mill which was finished with the 6½-in. shrinkage has given us good service, the failures per 10,000 tons being practically none. The 100-lb. rail from mill D has given us very good service, no failures in two years having been reported.

"The 90-lb. Bessemer rail from mill E gave us excellent service in track. We obtained no 100-lb. Bessemer rail from this mill. Both the 90 and 100-lb. open-hearth rails from this mill gave us very good service in track, the percentage of failures per 10,000 tons being comparatively low.

"Judging from the above I would say that we should not reduce our present shrinkage clause, also that the shrinkage should be made a matter of contract, as it is a variable and depends upon the section being rolled, the chemical composition of the steel and the distance of the saws from the finishing pass."

Mr. Crawford writes as follows:

"Our 100-lb. rails are finished at about 1650° F., allowing a shrinkage of 6⅝ to 6¾-in. with the exception of rails rolled by the Carnegie Steel Co., which have a shrinkage allowance of from 7 to 7⅛ in. Our rail records do not indicate that this variation affects the tendency to failure."

SUMMARY.

In all of the information as to actual tests which we are able to obtain, there is lacking anything which points to such decided differences in the quality of rails rolled at varying temperatures, as theoretical considerations have led some of us to expect. The differences are so slight that it seems hardly justifiable to go to any great expense in determining finishing temperatures any more accurately than is possible with the shrinkage clause, which on account of its easy application is by far the most convenient means of checking the finishing temperature.

Respectfully submitted on behalf of the sub-committee,

E. F. KENNEY,
Chairman.

APPENDIX II.

PROPOSED REVISIONS IN PRESENT STANDARD SPECIFICATIONS FOR STEEL AND STEEL PRODUCTS.

In this appendix are given in detail the revisions recommended in two of the present standard specification for steel and steel products. After the title of each specification is given its page number in the 1914 Year-Book, where the specification appears in its present standard form.

STRUCTURAL STEEL FOR BRIDGES: A 7–14 (page 40).

Section 6 (*b*).—Change to read:

"(*b*) In order to meet the required minimum tensile strength of full-size annealed eyebars, the purchaser may determine the tensile strength to be obtained in specimen tests; the range shall not exceed 14,000 lb. per sq. in., and the maximum shall not exceed 74,000 lb. per sq. in. The material shall conform to the requirements as to physical properties other than that of tensile strength, specified in Sections 6, 7 and 8 (*b*)."

AUTOMOBILE CARBON AND ALLOY STEELS: A 29–14 (page 149).[1]

1. *Section 2.*—After "Class B", line 1, insert "(Serial Designation: A 27)"; and omit the words ", are hereby made a part of these specifications, and."

2. *Section 5.*—Change "VIII", line 2, to "VI"; omit "III. . . . Automobile Nickel-Vanadium Steels" and "V. . . . Automobile Nickel-Chromium-Vanadium Steels", and change Tables IV, VI, VII and VIII to read III, IV, V and VI.

3. *Section 6.*—Change "VIII", line 5, to "VI."

[1] For amendments to the revision of these specifications, see p. 17.—ED.

4. *Section 12 (b).*—Change to read:

"(*b*) Tension and bend test specimens for material which is to be annealed or otherwise treated before use shall be cut, for rolled material, from properly annealed or similarly treated short lengths of the full section of the piece, and for forged material, from the treated forgings."

5. *Section 12 (e).*—After "surface", line 5, insert the following:

" when solid, and at any point midway between the inner and outer surfaces of the wall when bored,".

6. *Section 13 (a).*—Change "One", line 1, to read: "Unless otherwise specified by the purchaser, one."

7. *Appendix.*—Omit "Table III.—Automobile Nickel-Vanadium Steels" and "Table V.—Automobile Nickel-Chromium-Vanadium Steels"; and replace the remaining six tables by the following new Tables I–VI:

TABLE I.—AUTOMOBILE CARBON STEELS.

CARBON.		MANAGANESE.		PHOS.	SULF.
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over
0.10	0.05–0.15	0.45	0.30–0.60	0.045	0.05
0.20	0.15–0.25	0.45	0.30–0.60	"	"
0.25	0.20–0.30	0.65	0.50–0.80	"	"
0.35	0.30–0.40	0.65	0.50–0.80	"	"
0.45	0.40–0.50	0.65	0.50–0.80	"	"
0.95	0.90–1.05	0.35	0.25–0.50	0.04	"
SCREW STOCK.					
0.14	0.08–0.20	0.55	0.30–0.80	0.12	0.06–0.12
STEEL CASTINGS, CLASS B.					
As required for the chemical and physical properties. See Standard Specifications for Steel Castings (Serial Designation: A 27).					

All values are expressed in per cent.

TABLE II.—AUTOMOBILE NICKEL STEELS.

CARBON.		MANAGANESE.		PHOS.	SULF.	NICKEL.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.
0.15	0.10–0.20	0.65	0.50–0.80	0.04	0.045	3.50	3.25–3.75
0.20	0.15–0.25	"	" "	"	"	"	" "
0.30	0.25–0.35	"	" "	"	"	"	" "
0.35	0.30–0.40	"	" "	"	"	"	" "
0.40	0.35–0.45	"	" "	"	"	"	" "

All values are expressed in per cent.

TABLE III.—AUTOMOBILE NICKEL-CHROMIUM STEELS.

WITH 1.25 PER CENT NICKEL.

CARBON.		MANGANESE.		PHOS.	SULF.	NICKEL.		CHROMIUM.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.	Desired.	Permissible Range.
0.20	0.15–0.25	0.65	0.50–0.80	0.04	0.045	1.25	1.00–1.50	0.60	0.45–0.75
0.25	0.20–0.30	"	" "	"	"	"	" "	"	" "
0.30	0.25–0.35	"	" "	"	"	"	" "	"	" "
0.35	0.30–0.40	"	" "	"	"	"	" "	"	" "
0.40	0.35–0.45	"	" "	"	"	"	" "	"	" "

WITH 1.75 PER CENT NICKEL.

0.20	0.15–0.25	0.45	0.30–0.60	0.04	0.04	1.75	1.50–2.00	1.10	0.90–1.25
0.30	0.25–0.35	"	" "	"	"	"	" "	"	" "
0.40	0.35–0.45	"	" "	"	"	"	" "	"	" "
0.50	0.45–0.55	"	" "	"	"	"	" "	"	" "

WITH 3.00 PER CENT NICKEL.

0.15	0.10–0.20	0.60	0.45–0.75	0.04	0.04	3.00	2.75–3.25	0.80	0.60–0.95
0.35	0.30–0.40	"	" "	"	"	"	" "	"	" "
0.50	0.45–0.55	"	" "	"	"	"	" "	"	" "

WITH 3.50 PER CENT NICKEL.

0.20	0.15–0.25	0.45	0.30–0.60	0.04	0.04	3.50	3.25–3.75	1.50	1.25–1.75
0.40	0.35–0.45	"	" "	"	"	"	" "	"	" "

All values are expressed in per cent.

TABLE IV.—AUTOMOBILE CHROMIUM STEELS.

CARBON.		MANGANESE.		PHOS.	SULF.	CHROMIUM.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.
0.20	0.15–0.25	.....[a]	.....[a]	0.04	0.045	0.75	0.65–0.85
0.40	0.35–0.45	.....[a]	.....[a]	"	"	"	" "
0.65	0.60–0.70	.....[a]	.....[a]	"	"	"	" "
0.95	0.90–1.05	0.35	0.20–0.45	0.03	0.03	1.00	0.90–1.10
1.20	1.10–1.30	"	" "	"	"	"	" "
0.95	0.90–1.05	"	" "	"	"	1.20	1.10–1.30
1.20	1.10–1.30	"	" "	"	"	"	" "

[a] In these three grades the specified percentages of manganese and silicon may be either of the following: manganese, 0.35 desired (permissible range, 0.25–0.50) and silicon, not over 0.20; or manganese, 0.70 desired (permissible range, 0.60–0.80) and silicon, 0.15–0.50.

All values are expressed in per cent.

TABLE V.—AUTOMOBILE CHROMIUM-VANADIUM STEELS.

CARBON.		MANGANESE.		PHOS.	SULF.	CHROMIUM.		VANADIUM.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.	Desired.	Not Under.
0.20	0.15–0.25	0.65	0.50–0.80	0.04	0.04	0.95	0.80–1.10	0.18	0.15
0.25	0.20–0.30	"	" "	"	"	"	" "	"	"
0.30	0.25–0.35	"	" "	"	"	"	" "	"	"
0.35	0.30–0.40	"	" "	"	"	"	" "	"	"
0.40	0.35–0.45	"	" "	"	"	"	" "	"	"
0.45	0.40–0.50	"	" "	"	"	"	" "	"	"
0.50	0.45–0.55	"	" "	"	"	"	" "	"	"
0.95	0.90–1.05	0.35	0.20–0.45	"	0.03	"	" "	"	"

All values are expressed in per cent.

TABLE VI.—AUTOMOBILE SILICO-MANAGANESE STEELS.

CARBON.		MANGANESE.		PHOS.	SULF.	SILICON.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.
0.50	0.45–0.55	0.70	0.60–0.80	0.045[a]	0.045	1.95	1.80–2.10
0.60	0.55–0.65	0.60	0.50–0.70	0.045[a]	0.045	1.65	1.50–1.80

[a] Steels made by the acid process may contain 0.05 maximum phosphorus.

All values are expressed in per cent.

DISCUSSION ON THE REPORT OF COMMITTEE A-1.

MR. G. K. BURGESS (*presented in written form*).—The report of Sub-Committee I on Finishing Temperatures of Rails deals somewhat prominently with the findings in and inferences to be drawn from Technologic Paper No. 38[1] of the Bureau of Standards, and it is, perhaps, therefore in order for the writer to contribute to this discussion. At the outset, he would state he is rejoiced to see that Sub-Committee I on Steel Rails and Accessories is imbued with the idea of the importance of the subject of finishing temperatures of rails and every one will welcome the positive contributions contained in the report to our knowledge of the properties and service of rails as influenced by finishing temperatures. Mr. Burgess.

The report of the sub-committee contains no specific recommendations regarding the "Shrinkage Clause" in the rail specifications of the Society, from which it seems fair to conclude that the sub-committee considers this clause has some significance in its present form, although the report itself also closes with a statement that, from the evidence obtained by the sub-committee "there is lacking anything which points to such decided differences in the quality of rails rolled at varying temperatures as theoretical considerations may have led some of us to expect."

It is respectfully submitted as axiomatic that either the shrinkage clause means something or it means nothing, but it cannot mean both. It is also evident that in the rail mill a suitable shrinkage allowance must be made or the cold rails will not be of the required length. There is, however, a fundamental difference in principle between what is the mill's convenience in manufacturing and a supposedly upper limit of

[1] "Observations on Finishing Temperatures and Properties of Rails," by G. K. Burgess, J. J. Crowe, H. S. Rawdon, and R. G. Waltenberg, Technologic Paper No. 38, Bureau of Standards, 1914.

Mr. Burgess. finishing temperatures which the specifications say the mill must not exceed. The writer would like to ask the sub-committee if it has any information of the percentage of rejections due to hot-finishing under the shrinkage clause—not rejections because of incorrect cold length as such, but on account of temperature of rolling?

The shrinkage clause permits a maximum shrinkage of $6\frac{3}{4}$ in. in 33 ft. for a 100-lb. rail, but only $6\frac{7}{16}$ in. for a 75-lb. rail, corresponding to a difference in finishing temperatures of some 60° F. Why this discrimination in favor of the heavy section? Is the answer to be sought in the fact that the lighter section has different and less desirable properties when rolled 60° F. hotter than is allowed by the specifications, or was this allowable "$\frac{1}{16}$ in. for each increase of 5 lb. in the weight of the section" put into the specifications because, in the mill, starting with ingots (or blooms) at the same temperature, the rails of heavy section will naturally be finished hotter than the lighter for a given mill train and speed? Or, in other words, does the $\frac{1}{16}$ in. per 5 lb. represent a manufacturing convenience or a necessary limitation on the operation in view of the properties of the finished rail? If the former, it is not needed in the specifications; if the latter, the report of the sub-committee does not give sufficient evidence on the desirability of having a higher upper limit for finishing heavy sections.

As to the actual maximum finishing temperatures permitted by the shrinkage clause, according to the Bureau of Standards' measurements[1] they amount to 1120° C. (2045° F.) for 100-lb. Bessemer rails, or almost exactly the usual temperature of the ingot in the blooming mill; although the sub-committee, as evidenced by the last sentence of its report, are content with this shrinkage allowance. The question may also be asked, in view of the undoubted fact that rails finished too cold may be dangerous: Why is there not a lower shrinkage limit as well as an upper?

The sub-committee advances arguments for preferring the shrinkage method of measuring finishing temperatures to the pyrometric method described in Technologic Paper No. 38.

[1] *Loc. cit.*

Mr. Burgess.

The authors of that paper, when recommending the latter, considered all the points now raised by the sub-committee, several of which apply with equal force to both methods. It is of course evident, whether it is a preferred method or not, that when correctly used, the shrinkage of a rail may be used as a measure of its temperature at the hot saw. The writer considers, however, that he and his associates have proved the present maximum shrinkage allowance is of no practical significance and is moreover misleading, since it permits (according to our measurements) finishing rails at a temperature some 800° F. above the critical temperature (1240° F.) of rail steel, whereas, it is evident from the discussion attending the establishment of the shrinkage clause, that the intention was to limit finishing to slightly above this recalescence point.

The sub-committee objects that the optical pyrometric method used in these measurements does not give the temperature of the rail and that the shrinkage is controlled by the flange. There were, however, temperature measurements made for the sub-committee's report, but there does not appear to be included the name of the pyrometer used or a statement as to whether the temperature results from the several mills are really comparable. There also appear to be several inconsistencies in the report in respect to finishing temperatures and shrinkage. In the writer's opinion, this flange effect is of little or no consequence, at least with the more recently developed American sections, and it is always to be borne in mind that at the recalescence point any ordinary rail section will take up a practically constant temperature throughout, this phenomenon acting therefore to diminish the flange effect; and furthermore, this recalescence or equalizing point being below the temperature of the rail at the hot saw, the method of measuring temperatures there bears no necessary relation to the history of the rail below the critical range.

The writer is surprised to note the opinion of the sub-committee, on which there are several mill representatives, that if rail-finishing temperatures were measured by a pyrometer this would be a costly operation and it would be difficult to

Mr. Burgess. locate and sort the cold rails in terms of their finishing temperatures. Is there not room on the 33 ft. of the rail web to stamp the ingot number which, with the heat number and rail letter now stamped, will absolutely identify every rail? The pyrometric observer—who may be a manual training graduate at $400 or $500 a year with his pyrometer kit costing $100 to $250—will have no difficulty in following the heat numbers from his station. If, therefore, as the sub-committee appears to believe, it is nevertheless of some importance to control finishing temperatures, this can be done accurately, cheaply, simultaneously with the rolling, by the pyrometric method described.[1]

It does not seem to the writer that the evidence offered by the sub-committee on the relation of finishing temperatures to properties and service of rails, although undoubtedly of value, is very conclusive one way or the other for several reasons. In some of the experiments the temperature range is too small, in all of them the pyrometric method is but vaguely described or only hinted at, the various sets of data relate usually to rails of different or unstated composition or method of manufacturing and of various weights and sections, thus introducing uncertain and numerous variables which will influence the physical properties measured, but above all there have been too few observations taken to reach definite conclusions.

The problem, apparently, can only be solved by comparing the properties and behavior in like service of several thousand tons of rails which are as identically similar as may be in all respects, except that one-half say should be rolled and finished hot and the other half cold; or better, there should be three grades, the temperature of each of which should be controlled exactly by modern pyrometric methods. The writer, representing the Bureau of Standards, would be pleased to have the opportunity to cooperate with the sub-committee in a practical program of this kind, which would not be difficult of execution and which might solve a problem which has perplexed those interested for the past fifteen years or more.

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[1] *Loc. cit.*

MR. J. J. CROWE (*presented in written form*).—Referring to the report of Sub-Committee I on Finishing Temperature of Rails, it has been proved that the finishing temperature, within the limits of their experiments, does not affect the properties of rails. The results show that rails having a much larger shrinkage than that permitted by the specifications of the Society are as good as those finished with a shrinkage coming within the specifications. Why not strike out the shrinkage clause and let the mills finish at whatever temperature suits them best, until such time as it is conclusively proven that there is a best finishing temperature or best finishing temperature interval, and then measure the finishing temperature by the shrinkage or any other convenient method which will give satisfactory results? Mr. Crowe.

MR. E. F. KENNEY (*Chairman of Sub-Committee I, of Committee A-1, on Steel Rails and Accessories—Closure by letter*).—Sub-Committee I, acting under instructions from Committee A-1, has carefully reviewed the criticisms of Mr. Burgess and Mr. Crowe, but fails to find either in the criticism of the report of the sub-committee or in the original paper prepared by Mr. Burgess and his associates, any evidence to show that rails rolled at the higher temperatures recorded by them are inferior to those rolled at the lower temperatures. The work done by the sub-committee, while it may not be as complete as Mr. Burgess would desire, at least gives some data regarding the properties of rails rolled at various temperatures and their service in track. In the opinion of the sub-committee, based on these specific experiments, as well as on other more general observation, the finishing temperature is not of the importance in affecting the qualities of the finished rail that some investigators may have concluded from theoretical consideration. Mr. Kenney.

The sub-committee does not favor the omission of the shrinkage clause for the following reasons:

1. It is in general use in the existing specifications used by practically all the buyers of rails.

2. There has been no evidence produced to indicate that it results in the acceptance of any inferior material that would be rejected by its omission, or by the substitution of other methods of governing the finishing temperature.

Mr. Kenney. 3. The practice of keeping the shrinkage allowance constant for rails of equal weight per yard, and providing certain limits of shrinkage for each weight of rails, is of considerable value to the manufacturer. The shrinkage clause puts into the specification the limits within which the figures are held in ordinary commercial practice.

REPORT OF COMMITTEE A-2

ON

STANDARD SPECIFICATIONS FOR WROUGHT IRON.

Committee A-2 submits the following report:

Sub-Committee I on Tubes and Pipe.—This sub-committee held joint meetings during the past year with Sub-Committee IX on Steel Tubing and Pipe, of Committee A-1, for the purpose of formulating specifications for (1) Lapwelded and Seamless Boiler Tubes for Stationary Service, and (2) Welded Steel and Wrought-Iron Pipe. The specifications,[1] which have been agreed upon by the joint committee, were submitted to letter ballot of Committee A-2 and were practically unanimously approved, the result of the ballot being as follows:

	Affirmative.	Negative.	Not Voting.
Specifications for Boiler Tubes.....	24	0	11
Specifications for Pipe.....	24	0	11

Sub-Committee III on Staybolt and Engine-Bolt Iron.—There was no occasion to hold meetings of this sub-committee during the past year. Recently, however, the question of re-inserting a vibratory requirement in the Standard Specifications for Staybolt Iron has been raised, and as a result of this interest and further information now available, the sub-committee will give this matter special attention during the ensuing year with a view to revising the specifications to include such a requirement.

Sub-Committee V on Chain Iron and Iron Chain.—The membership of this sub-committee was increased during the past year to include representatives of several of the leading chain manufacturers, ship-building interests, and Lloyd's Register of Shipping. The enlarged sub-committee held several meetings, and offer for the consideration of the Society proposed Standard Specifications for Iron and Steel Chain appended to this report.[1]

[1] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—Ed.

The Sub-Committee on Designs and Specifications of the Committee on Standard Freight and Car Equipment of the American Railway Association, having expressed an interest in these specifications, was invited to send representatives to the final meeting of Sub-Committee V and was furnished with copies of the draft of the proposed specifications. Business engagements, however, made it impossible for the Association to send representatives to the meeting, but Mr. G. L. Wall, chairman of the sub-committee, in acknowledging the invitation, advised that the Sub-Committee on Designs and Specifications had decided to recommend the adoption of our proposed specifications for Class B Chain, the only chain they use in car work. While the recommendations of Mr. Wall's sub-committee will have to be submitted to the American Railway Association for approval, there is little question that they will finally adopt that portion of our specifications applicable to their use.

The proposed specifications differ slightly from the specifications of the Master Car Builders' Association, but members of that Association, who are members of Sub-Committee V of Committee A-2, are of the opinion that the Association will revise their specifications to conform to the specifications proposed by this committee.

The proposed Standard Specifications for Iron and Steel Chain have been submitted to letter ballot of the committee consisting of 35 members, of whom 29 have voted affirmatively, 1 negatively, and 5 have refrained from voting.

This report has been submitted to letter ballot of the committee, which consists of 35 members, of whom 27 have voted affirmatively, 1 negatively, and 7 have refrained from voting.

Respectfully submitted on behalf of the committee,

S. V. HUNNINGS,
Chairman.

J. B. YOUNG,
Secretary.

[EDITOR'S NOTE.—For action taken on this report, see page 14.

The proposed Standards referred to in the report were adopted by letter ballot of the Society on August 21, 1915, and appear among the Standards in the 1915 Year-Book.]

REPORT OF COMMITTEE A-3

ON

STANDARD SPECIFICATIONS FOR CAST IRON AND FINISHED CASTINGS.

The attention of Committee A-3 during the past year has been directed chiefly to the revision of the present Standard Specifications for Malleable Castings. The sub-committee having this matter in hand has worked jointly with a similar committee from the American Foundrymen's Association, and has also had the cooperation of representatives of the Master Car Builders' Association.

The discussion at several meetings and through correspondence has resulted in a thorough ventilation of the subject and to an adjustment of views as indicated in the proposed revision appended to this report[1] under the title of "Proposed Revised Standard Specifications for Malleable Iron Castings."

These specifications were referred to letter ballot of the committee, which consists of 44 members, of whom 29 have voted affirmatively, 2 negatively, and 13 have refrained from voting. Therefore, the committee recommends that the specifications be referred to letter ballot of the Society for adoption.

The feeling prevails, however, that a change is bound to come sooner or later. This change will mean specific standard specifications for malleable castings intended for definite classes of work. Thus, it is well known that car castings of malleable iron must be soft enough to permit riveting, whereas conveyor chain links must be very strong and inelastic. These are diametrically opposite requirements, and yet such castings are usually made from the same heats in many establishments attempting to turn out work to specifications.

In presenting these proposed revised specifications for adoption, the committee therefore feels that the future will bring about a situation similar to that met with by Committee

[1] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

A–1, which has prepared specific specifications for the different classes of manufactured steel because it would not have been possible to have one general specification serve the industry properly.

Mention may be made of progress in the formation of a sub-committee on Standard Specifications for Soil Pipe and Fittings. Several conferences have been had with those most interested, but the matter has not progressed sufficiently for a definite report. Similarly, the matter of revising the present Standard Specifications for Car Wheels has been referred to the proper sub-committee for early attention.

Following closely upon the last annual meeting of the Society, Mr. W. F. Hillebrand, of the U. S. Bureau of Standards, the American member of Committee 1 (*b*) of the International Association for Testing Materials designated for the preparation of American proposals for Standard Methods of Sampling and Analysis of Pig and Cast Iron, has prepared the report in question which is appended hereto[1] under the title "Proposed Standard Methods for Sampling and Analysis of Pig and Cast Iron (for Export)." This was submitted by him to the leading chemists and metallurgists of the country, and enthusiastically approved by them as representing the best practice of this country.

These methods of sampling and analysis have been adopted by Committee A-3, as follows: affirmative, 27; negative, 3; not voting, 14. Therefore, the committee recommends that they be referred to letter ballot of the Society for adoption.

It is understood, of course, that if our European colleagues can in any way improve upon these proposals, we shall be only too glad to cooperate with them, to the end that our own practice may conform in every way to the most advanced thought of the world, and that uniformity may be brought about in so difficult a subject as fair sampling and the accurate analysis of a fair sample.

The American members of Committee 1 (*b*) of the International Association beg to report that they have been in continual touch with the European members of this committee, and although no further work has been accomplished on the other

[1] These methods are not reprinted here, but they appear among the Tentative Standards in the 1915 Year-Book.—ED.

side, owing to the prevailing trying situation, yet interest has not been lost there, and renewed activity has been promised upon the close of the war. We believe that a greater measure of understanding will then be found to exist for the needs of international commerce, as the result of the problems and destruction that have been faced, and that our work will result in lasting benefit to the human race.

This report has been submitted to letter ballot of the committee, which consists of 44 members, of whom 31 have voted affirmatively, none negatively, and 13 have refrained from voting.

Respectfully submitted on behalf of the committee,

RICHARD MOLDENKE,
Chairman.

GEORGE C. DAVIES,
Secretary.

[EDITOR'S NOTE.—For action taken on this report, see page 14.

The proposed revised Standard referred to in the report was adopted by letter ballot of the Society on August 21, 1915, and appears among the Standards in the 1915 Year-Book.

The proposed Standard referred to in the report was not referred to letter ballot of the Society (see page 14), and appears in amended form among the Tentative Standards in the 1915 Year-Book.

For Discussion on the report, see following page.]

DISCUSSION.

Mr. MacPherran.

MR. R. S. MACPHERRAN.—As a member of the committee, I voted against the approval of the proposed Methods for Sampling and Analysis of Pig and Cast Iron. My objection was based upon the proposed treatment of the pig-iron sample. It seems to me that the refinement of sieving is unnecessary if an ordinary size drill be used and care taken in mixing the sample. Sieving the sample into three parts with consequent apportioning of different amounts from each part would cause considerable extra work and greatly increase the chance of error in weighing.

In weighing out the portions for determination there would be three bottles for each sample, and the weight to be taken from each bottle would depend upon the percentage of the total sample in that bottle. As the proportion of fine and coarse drillings would be apt to be irregular, the weights to be taken would usually be in fractions of a gram. In practice, this system would be very inconvenient. In the determination of sulfur, for example, it is the custom to weigh out a number of samples at once. Under the present method, the same weight is taken of each sample and the weight (usually a 5-g. weight) is left on the scale pan. Under the proposed method, it would be necessary to shift the weights into fractions of grams three times for each sample to be started. While this might be necessary for the determination of graphite, it would seem to me to be entirely unnecessary for the other elements. As only a very small amount of pig iron is sold on a graphite specification. it did not seem to me that the proposed methods of sampling should be approved in their present form.

Mr. Hillebrand.

MR. W. F. HILLEBRAND.—I do not know that I have anything special to reply to the criticism that has been made just now; in fact, I did not hear all that the speaker said. Furthermore, I did not know until this afternoon that the report was to come up for discussion, therefore I have not prepared myself by a recent reading of it to meet the suggestions made as well as I should wish. There was a meeting here of the iron men

a year ago at which this method of sampling was considered pretty carefully, and the principle underlying it was accepted as sound. The method is also, in principle, one which is used abroad, recommended, I believe, by Bauer and Deiss, and I would not like to see any changes made in the meeting here at this time. It would be very unfortunate, in my opinion, if changes were made without full and careful consideration. Of course, if during the year in which it is proposed to use these tentative methods, valid objections are brought forward and presented to the committee having charge of possible revisions of methods, changes will no doubt be made; but it seems to me that in view of the growing requirement for accuracy of work, the method ought to stand. I wish to say, too, that these methods were not drawn up with any thought of their being used generally in this country for ordinary work, but were intended for international work in connection with export transactions, and it was not known by me when I helped to prepare them that they would be adopted, or that the proposition would be made to adopt them, for general use in this country. I do not make any firm stand, therefore, that the methods reported are, in their entirety, the best adapted for our use here. It is up to the iron men, it seems to me, to determine whether they want these methods or not, or wherein they would have them modified by the committee. Their wishes can be indicated during the year. **Mr. Hillebrand.**

MR. MACPHERRAN.—I did not mean to make any motion to change the report of the committee; I merely wished to register my own objection. I am perfectly willing to leave this matter stand till next year. I think the method will, in the meantime, show very clearly wherein it is unsatisfactory. **Mr. MacPherran.**

MR. ALBERT LADD COLBY.—All chemists will agree that in the analysis of pig iron and iron castings, for the constitutents usually covered in specifications, there is, for each constituent, more than one analytical method sufficiently accurate for routine work. The selection of the sample is of more importance than the selection of the analytical method, for unless samples truly represent an average of each lot, the care incident to very accurate analytical work is misspent energy. **Mr. Colby.**

The committee recommends that from each 40 tons of

Mr. Colby. pig iron, 10 pigs be selected at random, and that drillings be taken with a $\frac{1}{4}$-in. twist drill from the top and bottom of each pig. With such a sample, I think the committee's recommendations to weigh and sieve the entire sample, and take proportional weights of each sifted portion for the determination of each of the constituents covered by their proposed analytical methods, constitute an unnecessary refinement in routine work, especially in view of the large amount of extra work thereby involved. I think that only in the determination of graphite and total carbon is extra care necessary to obtain, in the weighed portion for analysis, the correct proportion of the very finely divided portion of the sample, and that for silicon, manganese, phosphorus and sulfur, the committee's recommendation, involving much extra work in weighing out the samples for analysis, is unnecessary in routine work.

Mr. Sweetser. MR. R. H. SWEETSER.—It seems to me that in sampling pig iron for the analysis of carbon, there should be more care taken in the preparation of the sample than for silicon, sulfur and manganese. At the present time, there is a demand for pig iron with lower carbon, especially lower total carbon. Recent cases have come to my attention where the analyses of total carbon and graphitic carbon were too low on account of the loss of graphitic carbon in the manipulation of the sample taken from the pig. It seems from the remarks that have been made that in regard to the sample for silicon and manganese, there need not be the careful manipulation that is necessary in preparing the sample for carbon and graphite determinations. There is going to be a loss of the fine particles of carbon unless the very greatest care is taken in handling the samples. Attention is called in a note to the Shimer method, which has been used in some cases and has shown a larger percentage of graphitic carbon than the ordinary method of sampling without any special reference to saving the carbon.

Mr. MacPherran. MR. MACPHERRAN.—I think it might be well to incorporate some provision for drilling slowly in order to have as little difference in size as possible. If you drill fast, you get large chips. If you drill slowly, you get fine chips, and it is much easier to get an average sample from fine drilling than from coarse drilling. I merely offer that as a suggestion.

MR. IRA B. LESH.—No provision seems to have been made for very hard irons, such as No. 6, which can be drilled only with difficulty. Then, too, pig iron very high in total carbon sometimes contains free graphite segregated in pockets near the top surface, which in drilling from the surface with one hole only, might give very incorrect carbon results. **Mr. Lesh.**

MR. J. H. GIBBONEY.—The methods of analysis suggested by the committee are excellent in their selection and arrangement, but the thought suggests itself that the usefulness of such standardization might be greatly extended if attention were directed during the coming year towards establishing some definite standing for several of the widely applied methods not included in this report. **Mr. Gibboney.**

It is generally recognized that in commercial work certain methods have a well-established status, due in large measure to a very satisfactory degree of refinement obtained under conditions of rapid application. Such methods are unquestionably very useful, if not actually required in foundry operations, for example, the evolution-titration method for sulfur, and the persulfate method for manganese. It is to be hoped that after investigation their continued use may be warranted, if not in their present details, then in such modified form as may be considered necessary.

MR. RICHARD MOLDENKE (*Chairman of Committee A-3*).— The Standard Methods of the American Foundrymen's Association have so far been used by the committee as well as in the general foundry industry. On the question of volumetric determinations for sulfur, those who have gotten 0.02 in this way, when the gravimetric method gave 0.08, will hardly be anxious to adopt the former method. **Mr. Moldenke.**

MR. GIBBONEY.—There was probably some reason that might have been controlling. The same objection might be advanced for certain steels. However, if, as was actually the case in certain methods for the analysis of steels, the details of applying the method could be slightly changed and the method retained, then such standardization work will have wider application and hence added usefulness. **Mr. Gibboney.**

REPORT OF COMMITTEE A-5

ON

CORROSION OF IRON AND STEEL.

Committee A-5 on the Corrosion of Iron and Steel was reorganized last June. The membership was enlarged so that it now has about thirty members, consisting of Government, railroad, university, and independent chemists and engineers and representatives of various manufacturers which produce typical iron and steel rust-resisting products.

The committee has had five general meetings during the year. At one of the first meetings it was decided to make a comprehensive test to determine the relative resistance of the various types of ferrous metals to atmospheric corrosion. The test is to consist of two series. The first, series A, will be made on commercial Bessemer steel, acid open-hearth steel, basic open-hearth steel, pure iron (made by the basic open-hearth process), and puddled iron, all to be obtained in the open market with the following chemical composition:

Element.	Bessemer.	Acid Open Hearth.	Basic Open Hearth.	Pure Iron.	Puddled Iron.
Carbon, per cent	0.07–0.13	0.07–0.13	0.07–0.13	under 0.02	not specified.
Manganese, per cent	0.35–0.50	0.35–0.50	0.35–0.50	under 0.03	
Sulfur, per cent	under 0.07	under 0.05	under 0.05	under 0.03	
Phosphorus, per cent	0.08–0.11	0.05–0.09	under 0.05	under 0.01	
Copper, per cent	under 0.03	under 0.03	under 0.03	under 0.03	

It was agreed that some of the sheets of the regular Bessemer, acid open-hearth and basic open-hearth steels should contain not over 0.02 per cent copper.

The second series, B, will be made on the copper-bearing metals, which will be of the same composition as above, except that the percentage of copper will be from 0.15 to 0.30. The sheets for this series will be supplied by a limited number of manufacturers.

The tests in both series will be made on uncoated sheets of approximately 36 by 96 in. in Nos. 16 and 22 gage. They

will be exposed on open-shed construction in three localities, one on the Atlantic sea-coast, one in an inland industrial center, and one in an inland rural section.

It is of especial importance that these tests be under strict protection and control, such as a military or naval reservation would afford. Permission has been given to erect the necessary sheds on the grounds of the Naval Academy at Annapolis, Md., at Fort Pitt, Pittsburgh, Pa., and at Fort Sheridan, Ill. All of the sheets will be sent to the Bureau of Standards at Washington, D. C., for sampling and recording. Series A will be analyzed to determine if they meet the specified requirements and Series B will be analyzed for record. Series A will be inspected at the mill by a competent inspector, whom the Pennsylvania Railroad Co. has kindly agreed to furnish. A sufficient sample from each sheet will be retained at the Bureau of Standards for such general study and investigation as may be found desirable as the test progresses.

The cost of these tests will be covered by subscription from the leading producers of these materials. A Sub-Committee on Finance has already obtained some $2500 for this work, which it is believed will be sufficient. All the details of the tests have not been finally decided upon, but it is confidently expected that the conditions will be so controlled that reliable information will be available when the tests are completed.

This report has been submitted to letter ballot of the committee, which consists of 31 members, of whom 22 have voted affirmatively, none negatively, and 9 have refrained from voting.

Respectfully submitted on behalf of the committee,

S. S. VOORHEES,
Chairman.

W. H. WALKER,
Secretary.

REPORT OF COMMITTEE A-8

ON

STANDARD SPECIFICATIONS FOR COLD-DRAWN STEEL.

The committee submitted to the Society two years ago two specifications: one for Bessemer Automatic Screw Stock and the other for Open-hearth Automatic Screw Stock, and recommended that these be published as tentative specifications, which was done. Last year the specifications for Bessemer Automatic Screw Stock were adopted as standard, but those for Open-hearth Automatic Screw Stock were held as tentative. This year a vote of the committee was taken to ascertain if these tentative specifications, as published in the 1914 Year-Book, should be recommended for adoption as standard. Nine members voted affirmatively, 2 negatively, and 2 refrained from voting. As a result of the above vote, the committee recommends the adoption as standard of these specifications, which are appended hereto.[1]

This report has been submitted to letter ballot of the committee, which consists of 13 members, of whom 10 have voted affirmatively, 2 negatively, and 1 has refrained from voting.

Respectfully submitted on behalf of the committee,

C. E. SKINNER,
Chairman.

[EDITOR'S NOTE.—For action taken on this report, see page 19.

The proposed Standard referred to in the report was adopted by letter ballot of the Society on August 21, 1915, and appears among the Standards in the 1915 Year-Book.]

[1] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

REPORT OF COMMITTEE B-1

ON

STANDARD SPECIFICATIONS FOR COPPER WIRE.

During the past year, Committee B-1 has continued consideration of work already under way, and has also taken up new work, as will appear later in this report.

In the last two reports of the committee, reference has been made to work undertaken in conjunction with a sub-committee of the Power Committee of the American Electric Railway Engineering Association, with a view to the formulation of specifications for trolley wire, which might be adopted as the standard by both societies. Specifications were tentatively proposed by the A. E. R. E. A. sub-committee, which were reluctantly accepted by the sub-committee of Committee B-1. But Committee B-1 could not agree to these specifications, which in some important respects were different from our standard specifications, and radically at variance with definitely expressed opinions of the committee. Therefore, in 1914, Committee B-1 reported postponement of final action on these proposed specifications, and began to collect data and opinions from a number of large electric railways using trolley wire, on their practice with respect to specifications, and the necessary requirements for such wire. This canvass showed that a considerable majority of those roads buying under specifications had already adopted substantially the requirements of the standard specifications of this Society. Many large purchasers were using no specifications, while others were buying a high-strength alloy wire instead of copper. In the meantime the Power Committee had presented to the American Electric Railway Engineering Association at its annual meeting, the proposed specifications which have been adopted.

Finally at a meeting of Committee B-1, with nine of the eleven members present, it was unanimously voted that Committee B-1 recommend no change in the present Standard Speci-

fications for Hard-Drawn Copper Wire in so far as they apply to trolley wire.

For the information of the Society, the committee makes this brief statement of the two points of difference between themselves and the Power Committee of the A. E. R. E. A.:

1. *Tensile Strength.*—The Power Committee were of the opinion that trolley wire should not be hard-drawn but should, in effect, be somewhat less than hard-drawn, that is, more nearly what is defined as medium hard-drawn; yet the values for strength proposed were, for minimum values, substantially those of our Standard Specifications for Hard-Drawn Copper Wire.

2. The Power Committee, after long consideration and after many tests had been made, appeared to agree that the twist test, upon the inclusion of which they were insistent, could only safely be applied qualitatively; yet they insisted upon specifying a definite minimum number of twists.

To neither of these points could Committee B-1 agree. The first they considered inconsistent. The second they felt was adequately covered in the specifications as offered for amendment later in this report, namely, by the requirement that the wire shall be free from imperfections not consistent with best commercial practice. In the opinion of Committee B-1, other tests than the twist test may be preferred for the inspection of wire, and the committee sees no reason to make arbitrary choice among them.

As the result of the canvass of the practice of electric railways, Committee B-1 was convinced of the desirability of offering specifications for high-strength alloy trolley wire, and tentative specifications are appended hereto.[1]

The Standards Committee of the American Institute of Electrical Engineers have started work on the standardization of the various kinds of copper cable, and cooperation of Committee B-1 in the preparation of standard specifications for such copper cable was welcomed. Joint meetings of sub-committees from the two main committees have been held, and, as a result, Committee B-1 is able to offer "Tentative Specifications for Bare Concentric-Lay Copper Cable: Hard, Medium-Hard, or Soft,"

[1] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

which are appended hereto.[1] With the presentation of these specifications, we desire to delete from our present standard specifications for copper wire all requirements applying specifically to copper cable.

Work is actively under way on the subject of tinned copper wire, and on extra-flexible cable, and we hope to cover those in our report next year.

In detail Committee B-1 recommends the following action:

1. Amend the Standard Specifications for Hard-Drawn Copper Wire (Serial Designation: B1–13):[2]

(*a*) By changing Section 2 to read:

"These specifications cover hard-drawn round wire, grooved trolley-wire, and figure-eight trolley wire, as hereinafter described."

(*b*) By the omission of the word "surface" from Section 3 (*a*).

(*c*) By the omission of the words "and for cable" from Section 4 (*a*).

(*d*) By the omission of the heading "Hard-Drawn Copper-Wire Cable or Strand," and of Sections 16, 17, 18 and 19.

(*e*) By the omission of Sections 16, 17 and 18 from the Explanatory Notes accompanying the specifications.

2. Amend the Standard Specifications for Medium Hard-Drawn Copper Wire (Serial Designation: B2–13):[3]

(*a*) By changing Section 2 to read:

"These specifications cover medium hard-drawn round wire, as hereinafter described."

(*b*) By the omission of the word "surface" from Section 3 (*a*).

(*c*) By the omission of the words "and for cable" from Section 4 (*a*).

[1] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.
[2] 1914 Year-Book, p. 254.
[3] *Ibid.*, p. 264.

(*d*) By the omission of the heading "Medium Hard-Drawn Copper-Wire Cable or Strand," and of Sections 10, 11, 12 and 13.

(*e*) By the omission of Sections 10, 11 and 12 from the Explanatory Notes accompanying the specifications.

3. Amend the Standard Specifications for Soft or Annealed Copper Wire (Serial Designation: B3–13):[1]

(*a*) By the omission of the word "surface" from Section 3 (*a*).

4. The printing in the Year-Book of the proposed "Tentative Specifications for Bare Concentric-Lay Copper Cable: Hard, Medium-Hard, or Soft."

5. The printing in the Year-Book of the proposed "Tentative Specifications for High-Strength Bronze Trolley Wire, Round and Grooved: 40 and 65-per-cent Conductivity."

This report has been submitted to letter ballot of the committee, which consists of 11 members, all of whom have voted affirmatively on all matters in the report save on the proposed Tentative Specifications for Concentric-Lay Copper Cable and the proposed Tentative Specifications for High-Strength Trolley Wire, on which 10 members have voted affirmatively and 1 negatively.

Respectfully submitted on behalf of the committee,

J. A. CAPP,
Chairman.

[EDITOR'S NOTE.—For action taken on this report, see pages 15–16.

The proposed amendments in the Standards referred to in the report were adopted by letter ballot of the Society on August 21, 1915. The Standards as amended appear among the Standards in the 1915 Year-Book.

The proposed Tentative Standards referred to in the report appear among the Tentative Standards in the 1915 Year-Book.]

[1] 1914 Year-Book, p. 272.

REPORT OF COMMITTEE B-2

ON

NON-FERROUS METALS AND ALLOYS.

Committee B-2 has only one piece of work to submit to the Society, namely, the proposed Standard Specifications for the Alloy: Copper 88 per cent, Tin 10 per cent, Zinc 2 per cent, appended hereto,[1] and recommends that they be referred to letter ballot of the Society.

Sub-Committee I on Pure Metals in Ingot Form has found the specifications for Lake and Electrolytic Copper satisfactory. They have under consideration a revision of the specifications for spelter, and specifications for tin were under consideration at the outbreak of the European war. The situation in Europe has so disturbed the markets that it is impossible to do anything under present conditions; in fact, it is quite possible that the present commercial standard may undergo changes. By next year it is hoped to present specifications for tin and for lead.

Sub-Committee II on Wrought Metals and Alloys greatly regrets its inability to present any specifications this year. It was the intention to propose complete specifications for high-strength brass and bronze rods. This purpose was, however, not accomplished for the following reasons:

Because of the failure on an important public work of certain material of this character made to inadequate specifications, the Bureau of Standards undertook and is now pursuing an investigation into the causes of such failures. Under these circumstances it was considered inadvisable to publish anything which might conflict with the findings of the Bureau. In addition, the considerable experimental work, which is necessary to furnish or confirm required data, was interfered with by the unusual conditions now and for several months past existing in the brass-rod mills. The necessity for care in proposing specifications for brass rod has recently been particularly emphasized

[1] These specifications are not reprinted here, but they appear among the Tentative Standards in the 1915 Year-Book.—Ed.

by the very insufficient and unsatisfactory specifications which are being employed in connection with the large amounts of material of this kind, now being required for war purposes.

It is confidently felt that by another year suitable specifications for these materials can be presented.

Sub-Committee IV on White Metals has been at work on lead-base and tin-base babbitts. Five or six grades are under consideration, and the methods of sampling, analysis and testing are being discussed. The work has been thoroughly mapped out and undoubtedly there will be results next year.

Two matters have caused more than passing discussion. The first is the determination of the elastic limit of alloys in tension and compression, which matter must be referred to Committee E-1 on Standard Methods of Testing. The second is the question of oxidation of bearing metals and some test to show it accurately, and in this we should like the benefit of the information of the Society at large.

This report has been submitted to letter ballot of the committee, which consists of 22 members, of whom 18 have voted affirmatively, 2 negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the committee,

WILLIAM CAMPBELL,
Chairman.

[EDITOR'S NOTE.—For action taken on this report, see page 16.

The proposed Standard referred to in the report was not referred to letter ballot of the Society (see page 16), and appears among the Tentative Standards in the 1915 Year-Book.]

DISCUSSION.

MR. G. K. BURGESS (*by letter*).—Since the work in non-ferrous metals at the Bureau of Standards is referred to in the report of Committee B-2, a statement concerning the status of certain of these investigations may be of interest to the Society. Mr. Burgess.

An investigation is being conducted relative to the failure of structural brasses of the type of Muntz metal, naval brass, manganese bronze, etc. The Bureau has had the cooperation of many prominent brass manufacturers who have furnished new material manufactured under known conditions, and of several large users of brasses and bronzes who have furnished both good and failed material which has been in service.

The main object of this investigation is to secure sufficient experimental data to permit the establishment of specifications for such materials which will allow as high physical properties—elastic limit and ultimate strength—as possible and yet insure that the material shall be sound, that is, free from danger of season cracking and similar failures caused by the processes of manufacture.

The first step has been to attempt to prove definitely whether or not brass failures of this type may be ascribed always to the presence of initial stresses. An extended survey of these stresses in failed and sound material has accordingly been carried out. Secondly, the attempt has been made to ascertain whether under present manufacturing practices there is any relation between the magnitude and distribution of initial stresses and the physical properties of such materials. Thirdly, the various methods, dilatometric, chemical (mercury etching, etc.) and otherwise of detecting and measuring such stresses have been studied with a view to discovering which of them is the quickest and surest.

The effect of annealing on the physical properties of internally stressed materials has also been studied.

This investigation is not yet finished, but Dr. Merica and Mr. Woodward, who have been carrying out these experiments,

Mr. Burgess. have nearly ready for publication an account of the work to date.

Further cooperation is invited, particularly of those who are in a position to furnish interesting material (cast, forged, rolled, etc.) which has been in service under known conditions.

It would appear that the knowledge generally available to engineers responsible for designing structures into which non-ferrous alloys enter is all too meager.

Regarding the alloy "88 Copper, 10 Tin, and 2 Zinc", the Bureau, acting in part on the advice of Sub-Committee III of Committee B-2, will issue shortly a circular embodying more extended and general information concerning the manufacture and properties of this alloy. There is also being carried out with the Institute of Metals a comparative series of foundry tests in which five foundries and the Bureau of Standards are taking part. The complete paper by Mr. Karr embodying the results of his work on the foundry factors influencing the properties of this alloy will appear shortly, as will also the metallographic investigations by Mr. Rawdon concerning the effects of oxides and of heat treatment.

Mr. Chase. MR. C. E. CHASE (*by letter*).—Any move towards standardizing the specifications for bronze is a desirable attack on a matter long needing attention, if existing specifications are considered. It would be well, however, to proceed slowly in a matter which has waited so long for attention and be sure that the ground is well covered before even tentative specifications are adopted. It is not only somewhat difficult to amend specifications once adopted, but the superseded ones are apt to persist in use as "standards of the A. S. T. M." even after revisions. The following points have occurred to the writer in reading the specifications for "Government Bronze" proposed by Committee B-2:

1. Section 3 gives the required chemical composition, with a liberal range for each element, but puts no limit on impurities. Most of the existing specifications for this class of material do limit either certain undesirable elements or else the total of all elements other than the alloying metals which are specified. Under these proposed specifications, using the minimum amount permitted of each element, the presence of upwards of 4 per

cent of other elements would be permitted, which might well render the alloy entirely unfit for its intended use. Yet this alloy would meet the specifications, provided its tensile strength and elongation were sufficient. Mr. Chase.

2. The instructions contained in Section 4 for taking the sample for chemical analysis are quite complete, sufficiently so to meet the demands of much more exacting chemical requirements.

3. In specifying the tensile properties in Section 5, no elastic limit is called for. The writer realizes the difficulty of determining elastic limit in tension tests of material of this nature, as ordinarily conducted, and yet feels that knowledge of this property is so important to the user that it should be determined, at least approximately, in each case. It seems like a step backward to leave the elastic limit requirement out of an American specification for structural material. Information is certainly not widespread as to the ratio between the elastic limit and ultimate strength of gun metal. The designer should know from his specifications the elastic limit that he can expect and have assurance that the material will show that amount. A compression test on a short cylinder is now in common use to ascertain the elastic limit of the bronzes, by noting the first permanent set of an arbitrary amount.

4. The most serious objection to these proposed specifications seems to the writer to be the test coupon, which is practically cast to size.

It is well known that the shape of the test coupon has a marked effect on the physical properties of bronze and, as a result, the selection of a proper form for the coupon is one of the greatest difficulties in writing a specification for an alloy of this character. Careful distinction should be made between two distinct uses of tests, as affecting the selection of a coupon. The first case is that of the manufacturer who wishes to compare alloy compositions or to buy ingots, and who wants the physical characteristics of the metal with variations from all other influences than composition suppressed. The second case is that of the purchaser of a casting, who has designed it for a certain loading, on the assumption of its possessing certain physical properties, and wishes to know whether the casting

Mr. Chase. offered him possesses these qualities. The test coupon in this case should give results approximating as closely as possible to the average strength of the casting and should therefore be subjected to all the variables of pouring temperature, rate of cooling and composition that affect the casting itself. This is a difficult problem.

The test coupon specified by the committee may be proper for the first case, but it would certainly give misleading results in the second. This is well shown by the data and statements in Mr. L. P. Webbert's paper[1] before this Society last year, where this coupon in every case was shown to give results much higher than where tests were taken from the body of the castings. It may be necessary to vary the size of coupon in proportion to the thickness of the most vital part of the casting, or to depend on whether the casting is to be heavily machined or not, and it may not be possible to demand as high physical qualities for heavy castings as for light ones. These are matters for investigation.

It would seem to the writer to be better to leave the form of test coupon to be agreed upon between purchaser and manufacturer in each case, until this matter can be thoroughly studied.

5. The other specifications of this Society for castings contain a clause with regard to the defects, blowholes, etc., which will be sufficient to cause rejection. This is common in bronze specifications as well, and it would seem to be desirable in this case that such a clause be included.

6. Section 7 (*a*) calls for two tension tests from each lot or melt, but does not state what is to be done if one test meets the requirements and the other fails to do so.

7. Section 8 has apparently been adapted from the Standard Specifications for Manganese-Bronze Ingots for Sand Castings, which are for use between manufacturers. It seems rather elaborate for the simple chemical requirements in this instance, and clauses such as Sections 8 and 18 of the Standard Specifications for Steel Castings would seem preferable. These provide for a check analysis at the purchaser's option, and excess over

[1] "Study of the Strength of Non-Ferrous Castings: Comparison of Different Test Specimens," *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part II, p. 146 (1914).

the specifications for some elements on check analysis, and make provision for a claim for rehearing by the manufacturer if dissatisfied with the check analysis. Mr. Chase.

MR. WILLIAM CAMPBELL (*Chairman of Committee B-2— Closure by letter*).—Referring to the discussion of the Tentative Specifications for the Alloy: Copper, 88 per cent; Tin, 10 per cent; Zinc, 2 per cent, engineers in general will agree with Mr. Burgess that the available knowledge of non-ferrous alloys is all too meager. It is therefore proposed that part of the work of Committee B-2 shall consist in gathering reliable information on certain alloys, which will be presented to the Society next year. The work of the Bureau of Standards, when published, will undoubtedly give information of great value, which will be no small help to this committee in its future work. Mr. Campbell.

Committee B-2 will carefully consider Mr. Chase's criticisms, as well as others which it has received. It is still an open question whether it is necessary or desirable to make rigid chemical requirements along with definite physical properties. It would seem preferable to stiffen the physical requirements rather than put the chemical composition within very narrow limits. In regard to elastic limit, we shall be guided by Committee E-1.

The question of test coupon is important. It may prove necessary, in the case of castings, to have coupons of definite size for different-size castings, and to specify physical requirements for each size. This, however, can only be done when certain important factors such as casting temperatures have been thoroughly investigated.

In conclusion, it should be emphasized that Committee B-2 will gladly receive any helpful information that any member may possess, not only in regard to the alloy under discussion, but also for any alloy for which standard specifications may prove desirable. An appeal is therefore made to the Society at large for such information, which should be sent to the Chairman of Committee B-2 as soon as possible.

REPORT OF COMMITTEE C-1

ON

STANDARD SPECIFICATIONS FOR CEMENT.

The committee begs to report as follows:

In its report, presented at the annual meeting of the Society in June, 1913, the committee stated that in response to the following resolution, adopted at a meeting of the committee on March 7, 1912:

> "In order to secure uniformity in specifications for cement, it is recommended that the Board of Direction of the American Society of Civil Engineers, the Committee on Standard Specifications for Cement of the American Society for Testing Materials, and the Government Departmental Committee on Specifications for Cement, be each requested to appoint a Committee of three to confer for the purpose of reconciling differences,"

the Joint Conference on Uniform Methods of Tests and Standard Specifications for Cement was organized on October 24, 1912. This Conference has conducted investigations and inquiries of various kinds, and reached an agreement on April 28, 1915, in all matters excepting the method for the determination of time of setting. The report of the Conference was mailed to the members of Committee C-1 on June 5, 1915.

At a meeting of the committee held on June 15, 1915, at which there were present and represented thirty-two members out of a total membership of forty-seven, the report of the Joint Conference on Standard Specifications and Methods of Tests for Cement was presented and the following motion was adopted:[1]

> "It is moved, that the report of the Joint Conference be received, and referred to suitable sub-committees of Committee C-1 to investigate and report with recommenda-

[1] This motion was superseded by one adopted at a later meeting of the committee; see Discussion on p. 149.—Ed.

tions (if possible within one year); these sub-committees to be elected by Committee C-1 and to have a reasonable representation of the producing interests.

"It is further moved, that the representatives of Committee C-1 on the Joint Conference be instructed to oppose the publication in the public press or the journals of any of the organizations represented, of any parts of the report.

"This motion not to print specifically refers in the main to (1) changes in requirement for specific gravity (except as to wording); (2) changes in requirement for loss on ignition (except as to method for determination); (3) changes in requirement for fineness; (4) changes in requirement for soundness; (5) changes in requirement for time of setting; (6) changes in requirement for 1 : 3 sand-mortar strength; and (7) changes in method of storing briquettes."

The committee was asked to investigate and report on the autoclave test for the determination of soundness of Portland cement. The committee accordingly appointed a sub-committee consisting of Messrs. George J. Ray, George S. Webster, F. E. Schall, S. S. Voorhees, Ernest Ashton, and Richard L. Humphrey, Chairman, and the recommendation of this sub-committee that "the autoclave test for soundness should not for the present be adopted, for the reason that the investigations that have been made of this method do not show that it is in any way superior to the present test for soundness," was unanimously approved by the committee. The detail report of this sub-committee is appended hereto.

There was also referred to the committee the question of a standard screen scale. A sub-committee consisting of Messrs. Spencer B. Newberry, William K. Hatt, Clifford Richardson, J. H. Holst, C. W. Boynton, and S. S. Voorhees, Chairman, has reported that "the Executive Committee of the Society decided that no further consideration of this question by the Society was necessary. It is therefore recommended that no further action on the standard screen scale be undertaken by Committee C-1." This report was unanimously approved by the committee.

In response to the request of the Executive Committee,

Committee C-1 delegated its secretary to meet with the representatives of Committees C-7 and D-4 and Mr. Chapman to investigate the Chapman method for the determination of consistency. This special committee has had several meetings and conducted a number of investigations, and has reported that "the apparatus, when operated in accordance with the method recommended by the inventor, does not give sufficiently concordant results on 1:3 cement-sand mortars or on neat cement paste to warrant recommending its use as a reliable test for consistency, and further recommends that the special committee be continued for the purpose of making further investigations of this proposed method." This report was unanimously approved by the committee.

This report has been submitted to letter ballot of the committee, which consists of 43 members, of whom 25 have voted affirmatively, 1 negatively, and 17 have refrained from voting.

Respectfully submitted on behalf of the committee,

GEORGE F. SWAIN,
Chairman.

RICHARD L. HUMPHREY,
Secretary.

[EDITOR'S NOTE.—For supplement to this report, see Discussion on page 149.]

APPENDIX.

REPORT OF SUB-COMMITTEE ON ACCELERATED TESTS OF CEMENT.

The Sub-Committee on Accelerated Tests has had access to the test data which have been furnished the Joint Conference on Uniform Methods of Tests and Standard Specifications for Cement, and it has not, therefore, deemed it necessary to make additional tests.[1]

After a careful study and discussion of the matter, the sub-committee has decided that it is in entire accord with the conclusion of the Joint Conference, namely, that the autoclave test does not show appreciable merit as a test for soundness.[2] The sub-committee, therefore, pending its investigation of the whole question of accelerated tests, desires to report that, in its opinion, the autoclave test for soundness should not for the present be adopted, for the reason that the investigations that have been made of this method do not show that it is in any way superior to the present test for soundness.

In view of the present serious interference of the European war with the work of the International Committee on Accelerated Tests, the sub-committee has not deemed it desirable to conduct independent investigations in this country. The program of the International Committee is to organize sub-com-

[1] Data relating to the Autoclave Test were furnished by:
Pennsylvania Railroad Co.
Gustave Lindenthal.
Association of American Portland Cement Manufacturers.
Alpha Portland Cement Co.
Atlas Portland Cement Co.
Dexter Portland Cement Co.
Edison Portland Cement Co.
Lehigh Portland Cement Co.

Data and results of tests were examined at:
Laboratory, D. L. & W. R. R. Co., H. J. Force, Chemist, Scranton, Pa.
U. S. Bureau of Standards.
Dexter Portland Cement Company, Nazareth, Pa.

[2] Mr. Ray dissents from the statement "that the autoclave test does not show appreciable merit as a test for soundness." He thinks our final judgment of this test should await the results of investigations.

mittees in all foreign countries, and have each country through these sub-committees submit its ideas as to the purpose of accelerated tests. Having ascertained these, the committee hopes to devise a series of tests which will enable it to determine which of the various accelerated tests that have been heretofore proposed will satisfactorily fulfil the requirements.

The sub-committee is accumulating considerable information relating to accelerated tests which it hopes in due course to present in a report.

Respectfully submitted,

G. J. RAY,
F. E. SCHALL,
S. S. VOORHEES,
GEORGE S. WEBSTER,
ERNEST ASHTON,
RICHARD L. HUMPHREY,
Chairman.

DISCUSSION.

Mr. Humphrey.

MR. RICHARD L. HUMPHREY (*Secretary of Committee C-1*).— At a meeting of Committee C-1, held on Wednesday evening, June 23, it was agreed to substitute the following motion, adopted at that meeting, for the motion announced in the report of the committee as printed:

"That the report of the Joint Conference be received and referred to suitable sub-committees of Committee C-1, to investigate and report; said sub-committees to be appointed in accordance with the following rule of the committee:

"Art. II, Sec. 2.—Sub-committees proposed by the committee shall be appointed by the Advisory Committee subject to final ratification by the committee.

"That the Executive Committee of the American Society for Testing Materials be asked to confer with the Board of Direction of the American Society of Civil Engineers and suggest that they withhold from general publication the Joint Conference report until Committee C-1 has had a sufficient opportunity (not longer than one year) to consider the report."

I have been instructed by Committee C-1 to report the following revised list of sub-committees.[1]

[1] This list is not printed here. It will be found in the 1915 Membership Pamphlet, pages 187–189, and in the 1915 Year-Book, pages 664–666.—ED.

REPORT OF COMMITTEE C-3

ON

STANDARD SPECIFICATIONS FOR BRICK.

At the sixteenth annual meeting of the Society, Committee C-3 submitted proposed Standard Specifications for Building Brick and proposed Standard Specifications for Paving Brick which were published in the Proceedings.[1]

Both specifications have therefore been before the members of the Society for two years. The committee is unable to determine the extent to which they have been applied, but during this period very few comments have reached the committee. All means available have been utilized to obtain further information and to determine wherein the specifications as submitted should be revised or amended.

The committee therefore submits the following report consisting of two parts: the first being a progress report on building brick; the second a recommendation that the proposed Standard Specifications for Paving Brick, appended to this report,[2] be submitted to letter ballot of the Society for adoption.

I.—Building Brick.[3]

In the report of the committee submitted in 1914 the announcement was made that arrangements for cooperation had been completed with a number of university engineering laboratories, for the purpose of carrying on brick tests under the testing scheme proposed by this committee.[4] This cooperation of the various university laboratories was extremely encouraging and too much cannot be said in expressing the thanks of the committee to the heads of the laboratories for the very great courtesy and sacrifice, both of time and of money, in carrying on this work. That these cooperative tests are not more exten-

[1] Vol. XIII, p. 286 (1913).

[2] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—Ed.

[3] The Appendix to this report (pp. 160-162), added after the presentation of the report at the annual meeting, contains additional data relative to building brick.—Ed.

[4] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 188 (1914).

sive is in no way the fault of the laboratories, nor of the committee, but must be ascribed to the lack of interest on the part of manufacturers who have been requested to supply the graded samples. In spite of the urgent appeals by the secretary of the National Brick Manufacturers' Association, Mr. T. A. Randall, the response has been very meager. Some of the laboratories were not furnished any brick whatever, although from 10 to 15 manufacturers in each district were asked to cooperate; others received only a few sets of samples. The committee takes this opportunity to thank those manufacturers whose cordial cooperation was enjoyed. At the present time twelve laboratories have reported results and a number of reports are outstanding owing to failure to receive samples in time.

As was stated in last year's report, the tests made were the compression, transverse and absorption tests. The results furnished by the twelve laboratories are compiled in Table I. It should be noted that each value given is the average of five determinations.

In attempting to carry out the classification of the brick into classes A, B, C and D, on the basis of the compressive strength and the absorption, it was soon found that this was not practicable owing to the very wide fluctuations in porosity. It was found necessary therefore to discard the absorption values and to classify the brick on the basis of the compressive strength alone. This has been done in Table II; the classification being made as follows:

	AVERAGE COMPRESSIVE STRENGTH, LB. PER SQ. IN.
Class A	5 000 and over
Class B	3 500 to 5 000, excl.
Class C	2 000 " 3 500, "
Class D	1 500 " 2 000, "

It will be noted in this arrangement that Class D is rather poorly represented, and there appears to have been a rather general desire to submit only the better grades of brick. These results are very instructive, however, and no doubt will be of material benefit in discussing the arbitrary limits suggested for the classification of the bricks. Of special importance is the correlation of the compressive and the transverse strength, as

TABLE I.—RESULTS OF TESTS ON BUILDING BRICK REPORTED BY UNIVERSITY LABORATORIES.[1]

(EACH VALUE IS THE AVERAGE OF 5 DETERMINATIONS.)

Name of Laboratory and Person in Charge of Tests.	Place of Manufacture.	Compressive Strength, lb. per sq. in.	Modulus of Rupture, lb. per sq. in.	Absorption, per cent.	Remarks Concerning Brick. Kind.	Class.
University of Alabama: E. B. Kay	Birmingham, Ala.	14 964	1 926	4.81	Clay Brick	A
	" "	9 609	1 368	6.50	" "	A
	" "	4 482	733	5.57	" "	B
	" "	8 694	1 593	5.12	" "	A
	" "	9 393	1 874	1.72	" "	A
	Columbus, Miss.	4 653	693	11.99	" "	B
	Lovick, Ala.	11 200	1 857	4.45	" "	A
	Birmingham, Ala.	13 507	2 308	2.86	Shale Paving Brick	A
University of California: C. Derleth and A. C. Alvarez	Fresno, Cal.	8 636	1 031	7.56	Not stated	A
	" "	3 845	468	13.28	" "	B
	" "	3 062	445	13.33	" "	C
	" "	2 442	434	13.82	" "	C
	San Francisco, Cal.	2 933	791	13.93	" "	C
	" " "	3 294	908	14.84	" "	C
	" " "	2 740	754	17.44	" "	C
	" " "	1 951	501	18.36	" "	D
University of Illinois: A. N. Talbot and D. A. Abrams	Belleville, Ill.	2 282	187	23.50	Clay Brick	C
	" "	3 374	522	18.28	" "	C
	" "	2 771	582	17.86	" "	C
	" "	2 904	251	22.00	" "	C
	" "	7 788	1 007	14.18	" "	A
	" "	13 034	848	11.88	" "	A
	Chicago, Ill.	2 864	587	24.74	Clay Brick, stiff mud	C
	" "	1 687	626	21.26	" " " "	D
	" "	2 414	628	19.68	" " " "	C
	" "	2 869	1 064	16.60	" " " "	C
	" "	2 017	580	24.42	" " " "	C
	" "	2 584	462	25.24	" " " "	C
	" "	3 054	1 094	20.36	" " " "	C
	" "	3 470	1 618	14.74	" " " "	C
	Danville, Ill.	6 450	1 116	14.84	" " " "	A
	" "	10 145	1 303	7.38	" " " "	A
	" "	14 982	2 268	1.51	" " " "	A
	Urbana, Ill.	2 474[a]	426	19.48	" " " "	C
	" "	3 996[b]	805	14.80	" " " "	B
	" "	5 964[c]	1 238	13.60	" " " "	A
	" "	9 240[d]	1 926	8.70	" " " reburned	A
Purdue University: H. H. Scofield	New Albany, Ind.	7 355	1 158	14.39	Clay Brick, soft mud	A
	" " "	6 919	1 459	10.20	" " " "	A
	" " "	13 740	2 891	0.57	" " stiff mud	A
	Michigan City, Ind.	2 795	347	21.80	Sand-Lime Brick	C
	Crawfordsville, Ind.	2 502	337	21.80	Shale Brick, stiff mud	C
	" "	3 804	499	19.20	" " " "	B
	" "	9 926	1 151	14.00	" " " "	A
	" "	14 766	1 383	11.60	" " " "	A
	Lafayette, Ind (?)	3 110	716	.....	Clay Brick, soft mud(?)	C
	" "	4 134	585	17.95	" " " "	B
University of Maine: C. B. Brown	Saco, Maine	6 072	478	14.00	Clay Brick, stiff mud	A
	" "	9 076	1 241	10.55	" " " "	A
	" "	9 533	1 559	8.44	" " " "	A
	" "	12 013	1 085	2.76	" " " "	A
	Brewer, Maine	3 304	570	16.18	" " soft "	C
	" "	6 302	721	12.04	" " " "	A
	" "	7 873	1 171	8.74	" " " "	A
	" "	7 293	814	4.42	" " " "	A
	" "	4 847	1 009	14.59	" " stiff "	B
	" "	7 998	1 203	11.46	" " " "	A
	" "	8 200	1 283	10.90	" " " "	A
	" "	9 295	1 456	8.06	" " " "	A

[a] Tested endwise, 1400 lb. per sq. in.
[b] Tested endwise, 1926 lb. per sq. in.
[c] Tested endwise, 3137 lb. per sq. in.
[d] Tested endwise, 4280 lb. per sq. in.

[1] For additional data, see Appendix to this report, pp. 160–162.—ED.

TABLE I.—(*Continued.*)

Name of Laboratory and Person in Charge of Tests.	Place of Manufacture.	Compressive Strength, lb. per sq. in.	Modulus of Rupture, lb. per sq. in.	Absorption, per cent.	Remarks Concerning Brick. Kind.	Class.
Iowa State College: R. W. Crum	Mason City, Iowa	6 264	1 440	10.28	Clay Brick, stiff mud, side cut	A
	" " "	5 984	1 325	12.70	" " " " " "	A
	" " "	4 564	1 298	17.40	" " " " " "	B
	" " "	5 094	1 028	17.34	" " " " " "	A
Tulane University: W. B. Gregory and W. B. Koch	Plaquemine, La	3 293	517	21.54	Stiff mud, clay brick	C
	New Orleans, La	3 881	256	21.20	" " " "	B
	Covington, La	3 567	255	27.50	Soft " " "	B
	Pearl River, La	4 149	316	24.00	" " " "	B
	Fernwood, Miss	5 404	980	22.10	" " " "	A
	Slidell, La	4 454	577	20.20	Stiff " " "	B
	Norfield, La	3 928	285	22.10	Soft " " "	B
	Tangipahoa, La	4 341	667	17.80	" " " "	B
	Baton Rouge, La	2 364	323	26.80	" " " "	C
	Sibleyville, Ala	7 081	2 066	6.67	Dry pressed " " hard	A
	" "	3 399	1 229	10.18	" " " " soft	C
	Brookhaven, Miss	5 468	1 190	17.35	" "	A
	Slidell, La	3 711	310	20.19	Stiff mud	B
	Novick, Ala	10 981	3 354	4.35	" "	A
	Sibleyville, Ala	6 602	1 160	10.83	Dry pressed	A
	" "	6 873	1 183	8.31	" "	A
	" "	6 720	2 119	7.50	" "	A
Massachusetts Institute of Technology: C. M. Spofford	W. Barnstable, Mass.	1 564	281	17.90	Clay Brick, soft mud	D
	" " "	3 718	452	15.00	" " " "	B
	" " "	3 580	659	14.88	" " " "	B
	" " "	5 302	851	10.66	" " " "	A
	Ganic, N. H.	3 147	773	15.76	" " " "	C
	" "	3 092	812	15.50	" " " "	C
	" "	4 166	627	13.30	" " " "	B
	" "	4 474	845	12.21	" " stiff "	B
	" "	5 458	1 342	10.80	" " soft "	A
	" "	4 780	937	8.36	" " " "	B
	" "	5 448	1 420	6.93	" " stiff "	A
	" "	6 024	1 522	4.58	" " " "	A
	Worcester, Mass	2 950	416	14.60	Sand-Lime Brick	C
University of Michigan: F. N. Menefee	Detroit, Mich	2 278	....	.....	Clay Brick, stiff mud	C
	" "	2 398	....	.....	" " soft "	C
	" "	1 846	....	.....	" " " "	D
	" "	2 145	....	.....	" " " "	C
University of Pittsburgh: J. H. Smith	Watertown, Pa	4 542	438	13.90	Sand-Lime Brick	B
	" "	4 334	592	12.30	" " "	B
	Kittanning, Pa	12 780	2 329	2.06	Clay Brick, stiff mud	A
	Darlington, Pa	9 266	2 166	6.04	" " " "	A
	Beaver Falls, Pa	7 556	1 438	6.12	" " " "	A
	Bradford, Pa	6 122	1 124	8.95	" " " "	A
	" "	7 742	2 058	6.84	" " " "	A
	Pittsburgh, Pa	9 288	1 275	10.17	" " " "	A
University of Pennsylvania: H. C. Berry	Scranton, Pa	4 758	1 609	8.26	Clay Brick	B
	" "	5 718	1 769	7.15	" "	A
	" "	9 728	2 705	5.37	" "	A
	" "	9 052	2 226	4.61	" "	A
University of Washington: A. H. Fuller	Spokane, Wash.	4 156	564	17.90	Clay Brick, salmons	B
	" "	6 250	723	14.53	" " medium reds	A
	" "	7 458	918	12.84	" " dark reds	A
	" "	7 480	1 105	9.01	" " hard burned	A

TABLE II.—RESULTS OF TESTS ON BUILDING BRICK REPORTED BY UNIVERSITY LABORATORIES, CLASSIFIED ACCORDING TO COMPRESSIVE STRENGTH.[1]

CLASS A (OVER 5000 LB. PER SQ. IN.).

State.	Compressive Strength, lb. per sq. in.	Modulus of Rupture, lb. per sq. in.	Absorption, per cent.	Kind of Brick.
Alabama	14 964	1 926	4.81	Clay Brick.
	9 609	1 368	6.50	" "
	8 694	1 593	5.12	" "
	9 393	1 874	1.72	" "
	11 200	1 857	4.45	" "
	13 507	2 308	2.86	" "
	7 081	2 066	6.67	" "
	10 981	3 354	4.35	" "
	6 602	1 160	10.83	" "
	6 873	1 183	8.31	" "
	6 720	2 119	7.50	" "
California	8 636	1 031	7.56	" "
Illinois	7 788	1 007	14.18	" "
	13 034	848	11.88	" "
	6 450	1 116	14.84	" "
	10 145	1 303	7.38	" "
	14 982	2 268	1.51	" "
	5 964	1 238	13.60	" "
	9 240	1 926	8.70	" "
Indiana	7 355	1 158	14.39	" "
	6 919	1 459	10.20	" "
	13 740	2 891	0.57	" "
	9 926	1 151	14.00	" "
	14 766	1 383	11.60	" "
Iowa	6 264	1 440	10.28	" "
	5 984	1 325	12.70	" "
	5 094	1 028	17.34	" "
Maine	6 072	478	14.00	" "
	9 076	1 241	10.55	" "
	9 533	1 559	8.44	" "
	12 013	1 085	2.76	" "
	6 302	721	12.04	" "
	7 873	1 171	8.74	" "
	7 293	814	4.42	" "
	7 998	1 203	11.46	" "
	8 200	1 283	10.90	" "
	9 295	1 456	8.06	" "
Massachusetts	5 302	851	10.66	" "
Mississippi	5 404	980	22.10	" "
	5 468	1 190	17.35	" "
New Hampshire	5 458	1 342	10.80	" "
	5 448	1 420	6.93	" "
	6 024	1 522	4.58	" "
Pennsylvania	5 718	1 769	7.15	" "
	9 728	2 705	5.37	" "
	9 052	2 226	4.61	" "
	12 780	2 329	2.06	" "
	9 266	2 166	6.04	" "
	7 556	1 438	6.12	" "
	6 122	1 124	8.95	" "
	7 742	2 058	6.84	" "
	9 288	1 275	10.17	" "
Washington	6 250	723	14.53	" "
	7 458	918	12.84	" "
	7 480	1 105	9.01	" "

[1] For additional data, see Appendix to this report, pp. 160–162.—ED.

TABLE II.—*Continued.*

CLASS B (3500 TO 5000 LB. PER SQ. IN., EXCL.).

State.	Compressive Strength, lb. per sq. in.	Modulus of Rupture, lb. per sq in.	Absorption, per cent.	Kind of Brick.
Alabama	4 482	733	5.57	Clay Brick.
California	3 845	468	13.28	" "
Illinois	3 996	805	14.80	" "
Indiana	3 804	499	19.20	" "
	4 134	585	17.95	" "
Iowa	4 564	1 298	17.40	" "
Louisiana	3 881	256	21.20	" "
	3 567	255	27.50	" "
	4 149	316	24.00	" "
	4 454	577	20.20	" "
	3 928	285	22.10	" "
	4 341	667	17.80	" "
	3 711	310	20.19	" "
Maine	4 847	1 009	14.59	" "
Massachusetts	3 718	452	15.00	" "
	3 580	659	14.88	" "
Mississippi	4 653	693	11.99	" "
New Hampshire	4 166	627	13.30	" "
	4 474	845	12.21	" "
	4 780	937	8.36	" "
Pennsylvania	4 758	1 609	8.26	" "
	4 542	438	13.90	Sand-Lime Brick.
	4 334	592	12.30	" " "
Washington	4 156	564	17.90	Clay Brick.

CLASS C (2000 TO 3500 LB. PER SQ. IN., EXCL.).

Alabama	3 390	1 229	10.18	Clay Brick.
California	3 062	445	13.33	" "
	2 442	434	13.82	" "
	2 933	791	13.93	" "
	3 291	908	14.84	" "
	2 740	754	17.44	" "
Illinois	2 282	187	23.50	" "
	3 374	522	18.28	" "
	2 771	582	17.86	" "
	2 904	251	22.00	" "
	2 864	587	24.74	" "
	2 414	628	19.68	" "
	2 869	1 064	16.60	" "
	2 017	580	24.42	" "
	2 584	462	25.24	" "
	3 054	1 094	20.36	" "
	3 470	1 618	14.74	" "
	2 470	426	19.48	" "
Indiana	2 795	347	21.80	Sand-Lime Brick.
	2 502	337	21.80	Clay Brick.
	3 110	716	.....	" "
Louisiana	3 293	517	21.54	" "
	2 364	323	26.80	" "
Maine	3 304	570	16.18	" "
Massachusetts	2 950	416	14.60	" "
Michigan	2 278	...	.....	" "
	2 398	...	.....	" "
	2 145	...	.....	" "
New Hampshire	3 147	773	15.76	" "
	3 092	812	15.50	" "

CLASS D (1500 TO 2000 LB. PER SQ. IN., EXCL.).

California	1 951	501	18.36	Clay Brick.
Illinois	1 687	626	21.26	" "
Massachusetts	1 564	281	17.90	" "
Michigan	1 846	...	.....	" "

the latter appears to offer a most valuable criterion for the differentiation of bricks. It already appears that the absorption has not been of great service in this direction and its value as a determining factor must be decidedly modified.

The general average values obtained from these results for the compressive strength, modulus of rupture and absorption of the four classes are as follows:

	Class A.	Class B.	Class C.	Class D.
Compressive strength, lb. per sq. in.....	8493	4171	2791	1762
Modulus of rupture, lb. per sq. in.....	1482	668	621	469
Absorption, per cent.....	8.92	15.76	18.97	19.17

The Department of Experimental Engineering of the University of Minnesota has also kindly placed at our disposal the results of an extensive series of brick tests, in which the products of 12 brick plants were represented. Computing the averages of these values and dividing these into our classes A, B, C and D, the following figures are obtained:

TABLE III.—RESULTS OF TESTS FURNISHED BY UNIVERSITY OF MINNESOTA.

Class.	Test Series No.	Average Compressive Strength, lb. per sq. in.	Average Modulus of Rupture, lb. per sq. in.
A.....	3	5 663	1 253
B.....	1	4 762	926
C.....	8	2 584	576
D.....	3	1 739	403
E.....	2	907[a]	482

[a] Lower than Class D limit of 1500 lb. per sq. in.

These tests are not quite comparable with those made under the scheme of this committee, since the compressive test was made upon the whole brick, and the span in the transverse test was 6 in. However, the results are very valuable.

It might be well to recall also the results obtained by Prof. I. H. Woolson in connection with bricks from the Hudson River district, which are used so largely in New York City. The mean compressive strength of a considerable number of these bricks

was found to be 3943 lb. per sq. in., the average modulus of rupture 499 lb. per sq. in., and the average absorption 15.3 per cent.

Tests made by the Bureau of Standards on bricks obtained from 20 brick yards in the Chicago district showed an average compressive strength of 2156 lb. per sq. in., and a mean absorption of 23.79 per cent.

Objection has been raised, especially by Prof. A. N. Talbot and the Pittsburgh Laboratory of the Bureau of Standards, against the testing of half-bricks in the flatwise position, owing to the difficulty experienced in obtaining well-defined failing points, and the fact that the values are frequently in excess of the true strength. This is to be expected from Bauschinger's relation, and it would seem desirable to consider whether the half-bricks might not be tested on edge or whether the German practice of cementing together two half-bricks is a feasible proposition. The testing laboratory of the Ohio State University, and the Bureau of Standards, are now carrying on work in connection with this question. At the Bureau of Standards, in testing 178 bricks from 15 plants within a radius of 150 miles of Washington, D. C., the average compressive strength, flatwise, was found to be 6226 lbs. per sq. in.; edgewise, 5399 lb. per sq. in. The ratio of the results thus obtained by these methods of testing was 1.153 : 1. The tests of the bricks tested on edge were very much more satisfactory, resulting in definite failing points.

A matter of considerable importance is also the freezing test, for it is evident that the durability of building brick—their resistance to weathering—is really the most important factor. Considerable work has been done in this connection by a few laboratories but the material has not been correlated, and no general data are available as regards the resistance to freezing of bricks and other structural stone products from different parts of the country. The principal objection to the freezing test is its laborious and costly character. Recent work done at the Pittsburgh Laboratory of the Bureau of Standards with the Brard sodium-sulfate test seems to indicate that it promises to offer a substitute for the freezing test. By immersing clay cubes burned to different temperatures in a saturated solution of

sodium sulfate for 24 hours and then removing and drying them rapidly at 110° C., it was found that five treatments sufficed to break down all underburned materials. This work was repeated for three clays. The destructive action of the salt solution on products of weak structure was found to be so complete that the question might arise as to whether this test is too severe. It would seem necessary and important that this committee take up vigorously the question of the freezing test or substitutive methods for it.

II.—PAVING BRICK.

At the last annual meeting the committee reported that the proposed Standard Specifications for Paving Brick would be submitted this year with recommendation that they be referred to letter ballot of the Society for adoption. The report was supplemented by several brief amendments adopted by the committee and published in the Proceedings.[1]

During the discussion a desire was expressed by some members of Committee D-4 that the proposed specifications should be considered by a joint conference of Committees D-4 and C-3 before being referred to letter ballot. Such a conference was not required by the Society, but in order to obtain the benefit of any suggestions Committees D-4 wished to make, a request was at once sent to the chairman of that committee to designate a subcommittee to meet in joint session with the Sub-Committee on Paving Brick of Committee C-3 to consider the proposed specifications.

This sub-committee was designated. Two attempts were made by the chairman of the Sub-Committee on Paving Brick of Committee C-3 to secure a conference. These attempts were unsuccessful and no communications have been received from Committee D-4 in reference to any modification of the proposed specifications.

The amendments recommended last year and published in the Proceedings have been incorporated in the proposed specifications, and the proposed Standard Specifications for Paving Brick are herewith reported to the Society[2] with the recommenda-

[1] Vol. XIV, Part I, pp. 191–192 (1914).

[2] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

tion that they be submitted to letter ballot of the Society for adoption.

Part I of this report has been submitted to letter ballot of the committee, which consists of 14 members, of whom 13 have voted affirmatively, none negatively, and 1 has refrained from voting.

Part II of this report has been submitted to letter ballot of the committee, of whom 13 have voted affirmatively, none negatively, and 1 has refrained from voting.

Respectfully submitted on behalf of the committee,

A. V. BLEININGER,
Chairman.

D. E. DOUTY,
Secretary.

[EDITOR'S NOTE.—For action taken on this report, see page 23.

The proposed Standard referred to in the report was adopted by letter ballot of the Society on August 21, 1915, and appears among the Standards in the 1915 Year-Book.

For Addendum to the report, see following page.]

APPENDIX.

ADDITIONAL DATA ON BUILDING BRICK.

Subsequent to the printing of the report of Committee C-3, additional data were received from several institutions, which are compiled in the Tables IV to VII, inclusive.

TABLE IV.—RESULTS OF TESTS ON BUILDING BRICK (CONTINUATION OF TABLE I).

Name of Laboratory and Person in Charge of Tests.	Place of Manufacture.	Compressive Strength, lb. per sq. in.	Modulus of Rupture, lb. per sq. in.	Absorption, per cent.	Remarks Concerning Brick. Kind.	Class.
University of Maine: C. B. Brown.	Bangor, Me.	9 832	1 492	8.02	Clay Brick, soft mud	A
	" "	7 632	1 133	11.25	" " " "	A
	" "	5 850	926	14.65	" " " "	A
	" "	3 409	712	16.50	" " " "	C
	Revere, Me.	4 7a9	602	9.51	Sand-Lime Brick	B
	Brewer, Me.	7 293	1 493	4.31	Clay Brick, soft mud	A
	" "	7 8a3	1 133	8.73	" " " "	A
	" "	6 203	927	11.69	" " " "	A
	" "	3 305	712	15.54	" " " "	C
University of Illinois: A. N. Talbot.	Campus, Ill.	8 855	1 671	9.45	Clay Brick, stiff mud	A
	" "	5 966	1 208	12.64	" " " "	A
	" "	4 768	897	17.40	" " " "	B
	" "	4 356	821	19.52	" " " "	B
University of Kansas: H. A. Rice.	Coffeyville, Kan.	8 562	1 978	3.19	Shale Brick, stiff mud	A
	" "	7 253	2 047	3.32	" " " "	A
	" "	6 876	1 859	6.61	" " " "	A
	" "	7 341	2 735	8.47	" " " "	A
	" "	5 509	1 765	12.19	" " " "	A
	Cherryvale, Kan.	6 293	1 015	10.65	Clay Brick, stiff mud	A
	" "	4 133	1 026	13.58	" " " "	B
	" "	4 601	1 218	15.70	" " " "	B
	" "	3 670	1 060	17.42	" " " "	B
	" "	2 626	586	19.75	" " " "	C
	Independence, Kan.	6 798	2 133	3.70	" " " "	A
	" "	8 165	912	4.53	" " " "	A
	" "	6 953	1 638	8.40	" " " "	A
	" "	7 381	1 680	3.66	" " " "	A
	" "	7 193	1 766	4.58	" " " "	A
	" "	7 122	1 660	8.97	" " " "	A
	" "	5 037	961	13.50	" " " "	A
	Fredonia, Kan.	6 876	1 859	6.61	" " " "	A
	Humboldt, Kan.	5 244	1 316	19.30	" " " "	A
	" "	3 489	629	19.32	" " " "	C
	" "	4 944	1 047	20.60	" " " "	B
	Chanute, Kan.	6 629	2 335	16.12	" " " "	A
	Paola, Kan.	7 069	2 235	6.54	" " " "	A
	" "	11 148	1 778	7.67	" " " "	A
	" "	5 357	1 497	7.53	" " " "	A
	Iola, Kan.	5 319	963	16.44	" " " "	A
	Buffalo, Kan.	8 498	2 221	4.53	" " " "	A
	Buffville, Kan.	8 264	2 240	4.68	" " " "	A
	" "	7 783	1 511	7.16	" " " "	A
	" "	8 397	2 284	8.56	" " " "	A
	" "	7 312	1 070	11.30	" " " "	A
	Concordia, Kan.	4 736	347	16.54		B
	Lawrence, Kan.	7 185	1 394	8.95		A
	" "	6 662	1 336	7.10		A
	Oklahoma City, Okla.	3 702	645	17.30		B

TABLE V.—RESULTS OF TESTS ON BUILDING BRICK, CLASSIFIED ACCORDING TO COMPRESSIVE STRENGTH (CONTINUATION OF TABLE II).

CLASS A (OVER 5000 LB. PER SQ. IN.).

State.	Compressive Strength, lb. per sq. in.	Modulus of Rupture, lb. per sq. in.	Absorption, per cent.	Kind of Brick.
Illinois	8 855	1 671	9.45	Clay Brick.
	5 966	1 208	12.64	" "
Kansas	8 562	1 978	3.19	Shale Brick.
	7 253	2 047	3.32	" "
	6 876	1 859	6.61	" "
	7 341	2 735	8.47	" "
	5 509	1 765	12.19	" "
	6 293	1 015	10.65	Clay Brick.
	6 798	2 133	3.70	" "
	8 165	912	4.53	" "
	6 953	1 638	8.40	" "
	7 381	1 680	3.66	" "
	7 193	1 766	4.58	" "
	7 122	1 660	8.97	" "
	5 037	961	13.50	" "
	6 876	1 859	6.61	" "
	5 244	1 316	19.30	" "
	6 629	2 335	16.12	" "
	7 069	2 235	6.54	" "
	11 148	1 778	7.67	" "
	5 357	1 497	7.53	" "
	5 319	963	16.44	" "
	8 498	2 221	4.53	" "
	8 264	2 240	4.68	" "
	7 783	1 511	7.16	" "
	8 397	2 284	8.56	" "
	7 312	1 070	11.30	" "
	7 185	1 394	8.95	" "
	6 662	1 336	7.10	" "
Maine	9 832	1 492	8.02	" "
	7 632	1 133	11.25	" "
	5 850	926	14.65	" "
	7 293	1 493	4.31	" "
	7 873	1 133	8.73	" "
	6 203	927	11.69	" "

CLASS B (3500 TO 5000 LB. PER SQ. IN., EXCL.).

Illinois	4 768	897	17.40	Clay Brick.
	4 356	821	19.52	" "
Kansas	4 133	1 026	13.58	" "
	4 601	1 218	15.70	" "
	3 670	1 060	17.42	" "
	4 944	1 047	20.60	" "
	4 736	347	16.54	" "
	3 702	645	17.30	" "
Maine	4 749	602	9.51	Sand-Lime Brick.

CLASS C (2000 TO 3500 LB. PER SQ. IN., EXCL.).

Kansas	2 626	586	19.75	Clay Brick.
	3 489	629	19.32	" "
Maine	3 409	712	16.50	" "
	3 305	712	15.54	" "

TABLE VI.—RESULTS OF BRICK TESTS MADE AT THE UNIVERSITY OF WASHINGTON, UNDER THE DIRECTION OF PROFESSOR A. H. FULLER, BUT NOT IN CONNECTION WITH THE COOPERATION SERIES.

Kind of Brick.	Compressive Strength, lb. per sq. in.		Transverse Strength, lb. per sq. in:		Absorption, per cent.
	Saturated.	Dry.	Saturated.	Dry.	
Hard burned[1]	6 630	7 652	1 465	1 432	9.26
First Grade Common	3 300	3 512	955	1 160	21.10
Second Grade Common	1 118	1 048	276	340	25.80
Red Burlap	4 890	4 390	785	889	15.71
Dark Burlap	7 645	8 508	1 965	1 834	6.38

[1] Bricks of this and the following grades are obtained from Seattle and vicinity.

TABLE VII.—RESULTS OF TESTS TO DETERMINE RELATION BETWEEN COMPRESSIVE STRENGTH OF BRICKS CRUSHED ON FLAT AND ON EDGE.

Name of Laboratory and Person in Charge of Tests.	Place of Manufacture.	Compressive Strength, lb. per sq. in.		Absorption, per cent.	Remarks Concerning Brick.	
		On Flat.	On Edge.		Kind.	Class.
Ohio State University: Edward Orton, Jr., and H. A. Wegener	Zanesville, O.	12 298	8 945	5.26	Shale, stiff-mud, hard	A
	" "	6 534	4 693	13.19	" " " medium	A
	" "	3 088	2 580	17.67	" " " soft	C
	Cleveland, O.	13 262	7 659	2.06	" " " hard	A
	" "	13 001	11 283	3.42	" " " medium	A
	" "	10 134	5 934	8.01	" " " soft	A
	Somerset, O.	13 175	10 119	2.63	" " " hard	A
	" "	11 932	9 790	6.05	" " " medium	A
	" "	4 359	3 862	16.11	" " " soft	B
	Columbus, O.	13 232	15 139	1.19	" " " hard	A
	" "	12 260	10 878	6.75	" " " medium	A
	" "	6 253	5 669	12.75	" " " soft	A
	State Prison, O.	8 429	9 029	5.65	" " " hard	A
	" " "	8 797	9 368	6.94	" " " medium	A
	" " "	8 391	9 015	7.78	" " " soft	A
	Sandusky, O.	7 947	4 991	16.16	Glacial " " hard	A
	" "	7 742	4 111	18.39	" " " medium	A
	" "	4 052	1 905	21.42	" " " soft	B
	Cincinnati, O.	5 860	5 027	12.17	Alluvial " " hard	A
	" "	3 796	2 835	16.67	" " " medium	B
	" "	2 075	1 508	20.83	" " " soft	C
	Sandusky, O.	5 742	4 876	13.95	Glacial, soft mud, hard	A
	" "	3 603	3 337	21.53	" " " medium	B
	" "	2 258	1 679	26.67	" " " soft	C
	Dayton, O.	2 198	2 168	18.22	" " " hard	C
	" "	1 992	1 889	20.60	" " " soft	D
	Toledo, O.	4 171	4 465	20.84	" " " hard	B
	" "	1 971	1 696	23.34	" " " soft	D
	Cincinnati, O.	3 214	2 880	19.27	Alluvial, " " hard	C
	" "	1 640	1 126	23.15	" " " soft	C
	Columbus, O.	2 878	3 034	17.50	Glacial, " " hard	C
	" "	1 937	1 421	21.43	" " " soft	D
	Dayton, O.	2 572	1 912	12.66	Sand-lime	C
	Toledo State Hospital, O.	1 316	913	18.75	Cement Brick	E
Bureau of Standards, Pittsburgh, Pa.: J. G. Bragg	Pittsburgh, Pa.	10 540	8 190	5.85	Shale, stiff mud, hard, averages of 20 tests	A
	" "	5 990	5 110	11.5	Shale, stiff mud, medium hard, averages of 20 tests	B
	" "	2 410	1 830	16.51	Shale, stiff mud, soft, averages of 5 tests	C

REPORT OF COMMITTEE C-4

ON

STANDARD TESTS AND SPECIFICATIONS FOR CLAY AND CEMENT SEWER PIPES.

The committee begs to submit the following progress report:

At the last annual meeting the committee held a meeting, attended by twelve members, at which the officers were re-elected for a term of two years. Provision was also made for increasing the membership by three additional members. The chairman was instructed to appoint the following sub-committees:

1. Sub-Committee I, consisting of three members, to investigate and report on the loads transmitted to sewer pipes under conditions of use;

2. Sub-Committee II, consisting of six members, three engineers and three manufacturers (of which two are manufacturers of clay pipe and one of cement-concrete pipe), to conduct and report on a series of physical tests upon sewer pipes.

The officers of the committee have held twelve meetings during the year. Sub-Committee I reports that it has organized, and drawn plans for a structure and apparatus by means of which it is proposed to measure directly the actual or resultant loads which act upon sewer pipes, under conditions approximating those of actual use. The sub-committee has signified that it may require one year to complete the tests planned.

Sub-Committee II reports that it has organized, prepared plans for a portion of the testing apparatus to be employed, and has completed arrangements whereby a series of crushing tests will be conducted at two locations in the east, and at one or more locations in the west. Manufacturers of pipe materials represented on the sub-committee have signified their willingness to furnish specimens of pipes of both materials for testing purposes. This sub-committee has made a compilation of data relating to tests heretofore made, for determining the resistance of clay and cement-concrete sewer pipes to external loading.

Work has been done for the final consideration of the committee in formulating conclusions with respect to the various analytical data, Classes I and II, contained in the schedule

reported to the Society in 1911, and it is expected that these conclusions will be discussed by the committee at a meeting to be held at the time of the annual meeting of the Society.

The committee has been unable to add to the preliminary presentation of data of Class III, covering recommendations for laying sewer pipes, submitted to the Society in 1914. While final consideration of these data must await the full presentation of data with respect to the demands upon sewer pipes, and with respect to practical examinations and tests, there are also many reasons why the methods of handling and laying sewer pipes are controlling in themselves.

Therefore, it is recommended that the proposed "Recommended Practice for the Laying of Sewer Pipe," presented last year and appended to this report,[1] be accepted at this meeting and printed in the Year-Book for one year as tentative.

It is also recommended that the proposed "Definitions of Terms Relating to Sewer Pipe," presented last year and appended hereto,[1] be submitted to the Society for adoption as standard.

This report has been submitted to letter ballot of the committee, which consists of 20 members, of whom 15 have voted affirmatively, none negatively, and 5 have refrained from voting.

Respectfully submitted on behalf of the committee,

RUDOLPH HERING,
Chairman.

E. J. FORT,
Secretary.

A. J. PROVOST, JR.,
Vice-Chairman.

[EDITOR'S NOTE.—In presenting this report at the annual meeting, Committee C-4 recommended an amendment, which is given on page 23. For action taken on the report as amended, see pages 23–24.

The proposed Standard referred to in the report, as amended at the annual meeting, was adopted by letter ballot of the Society on August 21, 1915, and appears among the Standards in the 1915 Year-Book.

The proposed Tentative Standard referred to in the report appears among the Tentative Standards in the 1915 Year-Book.]

[1] The recommended practice and definitions are not reprinted here, but they appear in the 1915 Year-Book.—ED.

REPORT OF COMMITTEE C-6

ON

STANDARD TESTS AND SPECIFICATIONS FOR DRAIN TILE.

At the annual meeting in 1914 Committee C-6 presented for adoption proposed Standard Specifications for Strength Tests of Drain Tile, for Quality of Drain Tile, and Recommended Practice in Design and Construction of Tile Drains, which were adopted by letter ballot and have been printed in the Year-Book of the Society.[1]

During the year which has elapsed these specifications have made much progress among drainage engineers and elsewhere. Many reports of their adoption with favorable results have come to members of the committee.

The specifications so submitted and adopted were not considered to be complete. Active investigations were under way at the time, and have since been continued, with a view to securing additional experimental data, by the aid of which specifications for absorption tests, freezing and thawing tests, and perhaps other tests of quality of the material of the shell walls can be made. These investigations have been made for Committee C-6 by the University of Wisconsin, with Prof. M. O. Withey in charge. Clay drain tile of two different diameters, of three varieties of clay, and in each case of three different grades as to thoroughness of burning are being tested for strength, percentage of absorption and resistance to freezing and thawing. Similar tests are being made of concrete tile, of two different diameters, two different proportions, and three methods of manufacture. The investigations have progressed so far that it now seems almost certain that they can be finished and the results tabulated for Committee C-6 by September, 1915.

At its last meeting, held in Chicago, April 21, 1915, Committee C-6 entirely reconstituted its sub-committees, which are now directed to bring in final reports by the autumn of 1915.

[1] "Standard Specifications for Drain Tile," 1914 Year-Book, pp. 323–334.

Committee C-6 plans during the coming year to actively prosecute the work of completing its specifications and making a thorough revision thereof.

At the annual meeting of the Society in 1914, resolutions were passed which referred to the Executive Committee of the Society and to Committee C-6 the general question of policy involved in the adoption of proposed Recommended Practice in Design and Construction of Tile Drains. The Secretary-Treasurer of the Society and the Chairman of Committee C-6 edited the specifications adopted, so that they were printed in the Year-Book in such a way as to meet the point which had been raised, at least in part.

During the past year Committee C-6 by correspondence and by final personal conference discussed this subject with the Executive Committee, and Committee C-6 is in accord with the report which will be presented by that committee. The revision of the specifications during the coming year will be made in accordance with this report, and Committee C-6 will keep in close touch with the Executive Committee throughout the work, and act in accord with it on the question of general policy involved.

This report has been submitted to letter ballot of the committee, which consists of 15 members, of whom 8 have voted affirmatively, none negatively, and 7 have refrained from voting.

Respectfully submitted on behalf of the committee,

A. MARSTON,
Chairman.

J. T. STEWART,
Secretary.

REPORT OF COMMITTEE C-7

ON

STANDARD SPECIFICATIONS FOR LIME.

Committee C-7 submitted Specifications for Quicklime and Hydrated Lime at the last annual meeting of the Society with the request that they be printed as tentative specifications. Favorable action was taken relative to this request.[1] During the past year the committee has devoted its energies to the drawing up of proposed standard specifications for these materials.

At a meeting held for the purpose the criticisms of the tentative specifications were considered and certain revisions were made. The specifications as thus revised are appended to this report,[2] and the committee recommends that they be referred to letter ballot of the Society for adoption as standard. The vote by letter ballot of the committee on this recommendation was unanimous.

In order that the changes which have been made may be apparent, the sections which have been revised are printed below in the form in which they appeared as tentative in the 1914 Year-Book. The section numbers are the same as those printed in the proposed standard specifications appended to this report,[2] so that comparisons can be easily made. The reason for making a change is given when considered of sufficient importance.

SPECIFICATIONS FOR QUICKLIME.

2. Quicklime is divided into two grades:

(*a*) *Selected.*—Shall be a well-burned lime, picked free from ashes, core, clinker or other foreign material.

(*b*) *Run-of-Kiln.*—Shall be a well-burned lime without selection.

[1] See 1914 Year-Book, pp. 370-375.

[2] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

3. Quicklime is shipped in two forms:

(*a*) *Lump Lime.*—Shall be the size in which it comes from the kiln.

(*b*) *Pulverized Lime.*—Shall be lump lime reduced in size to pass a ¼-in. screen.

4. Quicklimes are divided according to their chemical composition into four types:

(*a*) *High-Calcium.*—Shall be quicklime containing over 90 per cent of calcium oxide.

(*b*) *Calcium.*—Shall be quicklime containing not under 85 per cent and not over 90 per cent of calcium oxide.

(*c*) *Magnesian.*—Shall be quicklime containing between 10 and 25 per cent of magnesium oxide.

(*d*) *Dolomitic.*—Shall be quicklime containing not under 25 per cent of magnesium oxide.

The word "types" was changed to "classes" because the committee felt that high-calcium, calcium, magnesian and high-magnesian limes were classes rather than types of lime.

The term "dolomitic" was changed to "high-magnesian" because the term "high-magnesian" is generic and may be applied to any lime or limestone having a relatively high magnesian content; while the term "dolomite" or "dolomitic" should, strictly speaking, be applied to a limestone in which the $CaCO_3$ and $MgCO_3$ are united in equal molecular proportions. The percentages of calcium oxide and magnesium oxide of a given class are grouped under chemical tests.

5. The particular grade, form and type shall be specified in advance by purchaser.

9. (*a*) The grade, type and chemical properties of quicklime shall be determined by standard chemical methods of analysis.

(*b*) Selected quicklime shall contain not under 90 per cent of calcium and magnesian oxides and not over 3 per cent of carbon dioxide.

(*c*) Run-of-kiln quicklime shall contain not under 85 per cent of calcium and magnesium oxides, and not over 5 per cent of carbon dioxide.

Here the requirements have been tabulated to follow the usual arrangements of the other specifications of the Society.

It will be noted that in this section of the proposed standard specifications, the limiting percentages of silica, alumina, and ferric oxide allowable

have been inserted. This was done because it was recognized that these elements tend to combine with the calcium oxide, thereby reducing in this proportion the available lime.

SPECIFICATIONS FOR HYDRATED LIME.

2. Hydrated limes are commercially divided according to their chemical composition into four types:

(*a*) *High-Calcium.*—Shall be hydrated lime, the non-volatile portion of which contains over 90 per cent of calcium oxide.

(*b*) *Calcium.*—Shall be hydrated lime, the non-volatile portion of which contains not under 85 per cent and not over 90 per cent of calcium oxide.

(*c*) *Magnesian.*—Shall be hydrated lime, the non-volatile portion of which contains between 10 and 25 per cent of magnesium oxide.

(*d*) *Dolomitic.*—Shall be hydrated lime, the non-volatile portion of which contains not under 25 per cent of magnesium oxide.

3. The particular type of hydrated lime desired shall be specified in advance of purchase.

The changes in Sections 2 and 3 were made for reasons given under the corresponding sections of the Specifications for Quicklime.

4. (*a*) The sample shall be a fair average of the shipment. Three per cent of the packages shall be sampled. The sample shall be taken from the surface to the center of the package. A 2-lb. sample to be sent to the laboratory shall immediately be transferred to an air-tight container, in which the unused portion shall be stored until the hydrated lime has been finally accepted or rejected by the purchaser.

(*b*) The non-volatile portion of hydrated lime shall contain not under 92 per cent of calcium and magnesium oxides.

(*c*) Hydrated lime shall contain not over 5 per cent of carbon dioxide and sufficient water to fully hydrate the calcium oxide present.

5. The type and chemical properties of hydrated lime shall be determined by standard methods of chemical analysis.

7. A pat about 3 in. in diameter, $\frac{1}{2}$ in. thick at the center tapering to a thin edge, shall be made on a clean glass plate about 4 in. square, from a paste composed of equal parts by

weight of hydrated lime and volume-constant Portland cement (gaged with only sufficient water to make the mixture workable. This pat, after hardening 24 hours in moist air, shall, when exposed in any convenient manner to steam above boiling water in a loosely closed vessel for 5 hours, show no signs of popping, checking, cracking, warping nor disintegrating.

8. Hydrated lime shall be packed either in cloth bags containing 100 lb. or in paper bags containing 40 or 50 lb. and the weight shall be plainly marked on each package.

12. Samples which represent rejected hydrated lime shall be preserved for five days from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

This report has been submitted to letter ballot of the committee, which consists of 18 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

JAMES S. MACGREGOR,
Chairman.

E. L. CONWELL,
Secretary.

[EDITOR'S NOTE.—For action taken on this report, see page 24.

The proposed Standards referred to in the report were adopted by letter ballot of the Society on August 21, 1915, and appear among the Standards in the 1915 Year-Book.]

DISCUSSION

MR. W. C. HANNA (*presented in written form*).—The matter which I wish to discuss is the inspection clause of the Specifications for Quicklime and for Hydrated Lime, Sections 11 (*c*) and 10 (*c*) respectively, which reads: Mr. Henna.

> "The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the quicklime (hydrated lime) ordered. The manufacturer shall afford the inspector all reasonable facilities for inspection and sampling, which shall be so conducted as not to interfere unnecessarily with the operation of the works."

I recommend that this paragraph be changed to the following:

> "The manufacturer shall afford the inspector all reasonable facilities for inspection and sampling of the quicklime (hydrated lime) ordered, which shall be so conducted as not to interfere with the operation of the shipping department."

The reasons for striking out the first sentence are:

1. The inspector need know nothing concerning the lime plant, for under the preceding paragraph (*b*) it is stated that the lime may be inspected either at the place of manufacture or the point of delivery. The inspector's work is to inspect the particular batch of lime set aside for shipment on a particular order, not the lime plant.

2. The first sentence gives the inspector a chance to inspect methods used by the manufacturer which in no way affect the quality of the lime but which do have a vital effect on the economy of operation. Possibly these methods would be passed to rival manufacturers or the information gained used in other ways which would cause injury to the manufacture:.

Mr. Hanna. 3. An inspector who is not acquainted with a particular plant is liable to receive injury while roaming around and in some states this possibly would lead to damage suits.

4. In order that the specifications be strong they should be reasonable. They should not become an unnecessary burden to the manufacturer.

In the second sentence of the paragraph I have made some changes because the inspector does not need to interfere with the operation of the works and certainly should have no privilege to do so.

Mr. Macgregor. MR. JAMES S. MACGREGOR (*Chairman of Committee C-7—Closure by letter*).—In reply to the points raised by Mr. Hanna, I would state that the sections relative to inspection are identical in substance with clauses covering inspection in almost all of the specifications of the Society. The inspector is not an employee of the producer; the producer, consequently, could not be held responsible under employers' liability laws or workmen's compensation laws for injuries which the inspector might receive.

The committee charged with drawing these specifications has, as members, several large producers and representatives of producers of lump and hydrated lime, none of whom raised objections to the points in question.

REPORT OF COMMITTEE C-9

ON

STANDARD TESTS OF CONCRETE AND CONCRETE AGGREGATES.

Committee C-9 has held three meetings during the year, at which there were present an average of eleven members. The work has been divided among nine sub-committees, each one being assigned a specific field for investigation. The work of each sub-committee is outlined in this report.

The method of procedure which is being followed in most of the investigations is to distribute series of tests to various commercial and college laboratories, with very complete instructions. These tests are arranged so that each series is duplicated several times and are designed to separate the individual variables, in order to determine one by one the specifications for each function.

In one series of investigations, which is of a distinctly scientific character and could not be handled satisfactorily except through a definite series of research tests, the committee has employed a chemist to make research investigations under the direction of Sub-Committee V.

In the various tests we have been favored with the cooperation of the following laboratories: University of Cincinnati; Columbia University, Cuyahoga County, Ohio; Harvard University; Gulick-Henderson Co.; R. W. Hunt Co.; University of Illinois; Iowa State College; Kansas State College; Lehigh University; Structural Materials Research Laboratory of Lewis Institute; Massachusetts Institute of Technology; New England Bureau of Tests; New York Public Service Commission; Office of Public Roads; Ohio State University; Oregon Agricultural College; Pittsburgh Testing Laboratory; City of Philadelphia; University of Texas; Westinghouse, Church, Kerr and Co., and the University of Wisconsin. Other laboratories are considering undertaking this work the coming fall,

including the Bureau of Standards, University of California, Colorado School of Mines, City of Hartford, New York State, Raymond Concrete Pile Co., and Spackman Engineering Co. Even with this cooperation the field of our tests as laid out is not yet covered and the committee invites offers from laboratories not included in the above list to cooperate with us and take up one of our series.

The committee has been fortunate in having for preliminary use the results of the investigations carried on by the Committee on Specifications and Methods of Tests for Concrete Materials, of the American Concrete Institute, published in their Journal for October and November, 1914.

At the first meeting of the committee it was voted that the work of these two committees be coordinated and that they act as a combined committee in making the researches and tests.

The work of Committee C-9, as previously stated, has been divided among nine sub-committees. Their personnel and an outline of the work of each is as follows:

Sub-Committee I on Finance.—H. A. Moore, *Chairman;* O. P. Chamberlain; F. W. Kelley.

The work of this sub-committee consists in providing funds by means of which the expenses involved in the prosecution of the work of other sub-committees will be taken care of.

Sub-Committee II on Laboratory Tests for Concrete and Laws of Mechanical Mixtures.—D. A. Abrams, *Chairman;* S. H. Graf; F. W. Renwick; Arthur N. Talbot; M. O. Withey.

This sub-committee has outlined certain tests on concrete and mortars with the view of establishing the best practice in making and testing concrete specimens in the laboratory, and to determine the effect of variations in the gradation of sizes of the aggregates on the strength and properties of the concrete. These tests cover a wide range and necessitate the making and testing of a large number of specimens. It is felt that only by making such tests exhaustive can information be obtained which will permit the drawing of definite conclusions. It is hoped that these tests will furnish information upon which can be based definite recommendations as to the practices which should be followed in testing concrete in the laboratory; and it is also hoped that definite conclusions can be reached as to the effects

of certain variations in the gradation of the sizes of the aggregate materials.

The following series of tests have been outlined as a part of the necessary investigations:

1. Comparison of metal and wood forms for standard laboratory tests of concrete.

2. Variations in strength and properties of concrete throughout the batch.

3. Effect of different methods of tamping and compacting.

4. Effect of condition of storage of specimens for standard compression test of concrete.

5. Method of capping test specimens preparatory to testing.

6. Effect of gradation of sand.

7. Effect of varying ratio of fine to coarse aggregates.

8. Effect of varying sizes of fine to coarse aggregates.

9. Strength of mortar as affected by the form of the test specimens.

Sub-Committee III on Sampling and Testing Field Concrete.—W. M. Kinney, *Chairman;* O. P. Chamberlain; R. S. Greenman; R. J. Wig.

In laying out the work for this sub-committee it was found that on a number of the larger concrete jobs field tests are being made, but there seems to be no uniformity of practice in making, storing, and testing the specimens. It was deemed wise, therefore, that this sub-committee select tentatively a method which seems to have the most merit, and recommend that wherever possible such tests be made.

The following tests have been outlined:

1. Comparison of four methods of storage during first two days after molding.

2. Comparison of methods of storage subsequent to first two days.

3. Study of the cold-weather effect on field specimens.

4. Comparison of prisms made in the field and in the laboratory with prisms cut from work.

5. It is considered within the realm of possibility that a portable core drill can be made to use in cutting test specimens from concrete already in place in the form of 6 by 12 or 8 by 16-in. cylinders.

Sub-Committee IV on Relative Values of Various Strength Tests.—A. T. Goldbeck, *Chairman;* R. S. Greenman; M. O. Withey.

In the field to be covered by this sub-committee there are certain fundamental problems which it is felt should be investigated as soon as possible. These may be stated as follows:

1. To establish the relative reliability of mortar strength tests for determining the suitability of sand for use in concrete.

2. A determination of the most desirable size and shape of mortar test specimens and the relation of tension to compression.

3. A determination of the most desirable size and shape of concrete test specimens.

Sub-Committee V on Impurities Affecting Fine Aggregates.—F. W. Kelley, *Chairman;* D. A. Abrams; E. D. Boyer; Lewis R. Ferguson.

The work of this sub-committee is as follows:

1. In securing samples of fine aggregates which have shown abnormal results when used for concrete.

2. To make tests on the samples secured with the view of determining the cause of the peculiar action noted.

3. To find, if possible, an economical corrective for such peculiarities.

In order to secure samples for this investigation, letters were addressed to a large number of persons throughout the United States and Canada, who it was thought might be able to assist in supplying samples of sand which would be of economic importance if the impurities could be removed. Considerable information has been collected concerning sands of this kind. Several samples have been received and are now being subjected to preliminary tests. The tensile and compressive strengths of mortars made from each of these sands will be compared with mortar from standard Ottawa sands, using various brands of Portland cement. Chemical analyses will be conducted on the foreign material in the sands, and an effort made to discover some method of treatment which will remove the defects. In searching for a corrective, the commercial aspect of the problem will be kept constantly in mind so that the method of correcting

used for each sand will be practical and the most economical one available.

Owing to the extremely technical nature of the tests involved in this investigation, a chemist has been employed by the committee to carry out the chemical work under the direct supervision of one of the members of this sub-committee.

Sub-Committee VI on Methods of Tests for Voids, Weights, Density, Specific Gravity and Consistency.—Cloyd M. Chapman, *Chairman;* A. T. Goldbeck; G. L. Lucas; J. L. Miner.

In the standardization of certain of these tests the committee is cooperating with other committees of the Society in order to arrive at specifications which will apply to all classes of work. The first series of tests laid out has been with reference to methods of determining weights and voids.

The variables to be standardized are (*a*) size of measure; (*b*) method of filling; (*c*) condition of sand.

(*a*) Four sizes of measures are being tried of the following capacities, 100 cc., 1000 cc., $\frac{1}{4}$ cu. ft., and 1 cu. ft., in order to find out whether it is necessary to make weight determinations on a large sample, such as $\frac{1}{4}$ cu. ft. or more. If smaller measures, such as 100 cc., or 1000 cc., give equally concordant results, they will be more easily used in the laboratory. The two larger sizes of measures are being tried in cylindrical and cubical shapes.

(*b*) Seven more or less different methods of filling the measures are being tried out. Each method as outlined has been in use by laboratories testing sand and each gives results differing more or less from the others.

(*c*) Two sets of determinations on condition of sand are being made; one with the sand dried at room temperature, the other with damp sand. Samples of two kinds of sand have been furnished by the committee to those performing these tests.

Sub-Committee VII on Methods of Tests of Coarse Aggregates.—E. R. Ashton, *Chairman;* O. P. Chamberlain; Cloyd M. Chapman; H. A. Moore; F. W. Renwick.

The work of this sub-committee is the investigation of methods of tests to determine the suitability of coarse aggregates for concrete to be used under varying conditions.

Sub-Committee VIII on Available Aggregates for Concrete.—R. J. Wig, *Chairman;* Lewis R. Ferguson; W. M. Kinney.

The work of this sub-committee is the compilation of localities throughout the United States where concrete aggregates are available. The cooperation of geologists of the United States Government in the various states will be solicited and also the assistance of engineers. The efforts of the committee will first be devoted to states in which there are few deposits of available aggregates.

Sub-Committee IX on Definitions.—Lewis R. Ferguson, *Chairman;* J. L. Miner.

The work of this sub-committee is as follows:

1. To collect as many of the definitions as it can secure which are pertinent to the work of Committee C-9.

2. To endeavor to secure the cooperation of all committees pertaining to concrete or correlated subjects of the various engineering societies in this country, with a view toward standardizing definitions pertaining to the testing of concrete and concrete aggregates.

All of the investigations as outlined above are under way. Detailed methods of tests together with definite instructions have been forwarded to a large number of colleges and commercial laboratories throughout the United States.

This report has been submitted to letter ballot of the committee which consists of 16 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

SANFORD E. THOMPSON,
Chairman.

LEWIS R. FERGUSON,
Secretary.

REPORT OF COMMITTEE C-11

ON

STANDARD SPECIFICATIONS FOR GYPSUM AND GYPSUM PRODUCTS.

Committee C-11 was organized during the past year and held its first meeting on December 10, 1914. Two meetings of the Advisory Committee were subsequently held. Sub-committees were appointed and their work outlined as follows:

Sub-Committee I on Gypsum for Various Uses.—H. J. Brown, *Chairman.*

The work of this sub-committee includes the development of specifications for (1) uncalcined and (2) calcined gypsum, for all of its known uses such as fertilizer, plaster, structural products, potteries, cement products, etc.

Sub-Committee II on Gypsum Plasters.—De Lagnel Haigh, *Chairman.*

The work of this sub-committee includes the development of specifications for all plasters in which gypsum is used, together with directions for application. This includes finishing coats as well as base coats, and virtually includes all uses of gypsum and mixtures of gypsum with other materials, where applied with a trowel. The work may be grouped under three headings: (1) cementitious base; (2) aggregates; and (3) application.

Sub-Committee III on Structural Gypsum Products.—W. A. Slater, *Chairman.*

The work of this sub-committee includes the development of specifications for manufactured articles such as (1) plaster board, (2) plaster block, and (3) general plaster products used in floor and roof or similar construction, such as column protection and shaft enclosures, together with specifications for erection.

Sub-Committee IV on Testing Methods.—W. E. Emley, *Chairman.*

The work of this sub-committee includes the development

of testing methods for determining the necessary physical, chemical and fire-resisting properties of gypsum. The sub-committee will also secure copies of the specifications and building laws of the various states, cities, and national organizations so that the methods of testing developed may conform to these requirements.

Sub-Committee V on Nomenclature.—S. G. Webb, *Chairman.*

The work of this sub-committee includes the development of definitions of the terms used in the gypsum industry in so far as they affect the work of Committee D-3.

These sub-committees have been organized only a few weeks and therefore have no reports to make at this time.

Committee D-3 was represented at a meeting of the National Fire Protection Association in New York and at a meeting held at the Underwriter's Laboratory in Chicago, called for the purpose of establishing specifications for plaster block.

This report has been submitted to letter ballot of the committee, which consists of 22 members, of whom 19 have voted affirmatively, none negatively, and 3 have refrained from voting.

Respectfully submitted on behalf of the committee,

R. J. WIG,
Chairman.

L. I. NEALE,
Secretary.

DISCUSSION.

Mr. R. J. Wig (*Chairman of Committee C-11*).—It is desired to invite discussion of the program of work of the Committee on Gypsum, especially in so far as it proposes to consider the methods of application and erection as part of the specifications for the finished product. Gypsum might be considered as a product similar to cement, although it differs essentially from cement in that its physical properties are materially affected by slight percentages of impurities often found in tap waters, and in that the method of application greatly alters its quality. Mr. Wig.

Mr. H. S. Spackman.—The question of covering in the specifications the application of gypsum plaster and the development of proper methods of use is in line with the proposed recommendation of methods for the placing of drain tile, sewer tile, etc. If this is permitted, it is going to place the Society more and more in the position of prescribing methods of use as well as specifications for material. A great many materials for which we prepare specifications are really raw materials. After they get into the hands of the user they are manufactured to a certain extent, yet when failures occur it is usually the material—the cementitious material in this particular instance—that is blamed, and not the workmanship. In the discussion yesterday, on concrete, it was developed that the durability of cement depended on the methods used in mixing and laying the concrete. I feel that if we let down the bars and consider it wise to prescribe methods of application of gypsum plaster, we immediately open the ground for methods of application of lime plaster, methods of application of concrete, methods of application of numerous other materials, the bitumens, etc.; and I believe it is a question that should be carefully considered, whether we should depart from our previous practice of simply considering the particular material as it is bought in the market, or try to govern its subsequent use. I believe the question is one that is worthy of a fuller discussion than can be given to it at this session. Mr. Spackman.

Mr. Douty. MR. D. E. DOUTY.—Committee C-3 on Standard Specifications for Brick spent nearly an entire day discussing the proposition of extending the work of that committee to questions of the application of brick and the methods of using them. I think it is unwise for this Society, in any of its work, to enter upon questions involving the application of material. The working out of a specification for the application of cement in the proportioning of an aggregate, and the manner in which it should be gaged, is well within the field of this Society, because concrete is before this Society as a material, and we are preparing specifications for concrete. We have thus far avoided questions of engineering practice. The preparation of specifications, the definitions of methods of testing, the methods of measuring physical and chemical quantities, the proportioning of chemical composition—those according to our present policy and according to the name of this Society, are matters with which it deals. It is the American Society for *Testing* Materials, not for the *application* of materials.

The Secretary. THE SECRETARY.—I think the previous speakers have voiced what, if it could be obtained, would express the composite sentiment on this subject of the Society at large. The reasons appear to be so evident that they need not be seriously discussed, at least at this time. The Executive Committee has placed itself on record, as stated explicitly in the annual report presented this year, that it is opposed in principle to including matters of engineering design or construction within the scope of activities of the Society, unless it can be shown conclusively that under certain rare conditions, exceptions should be authorized. It is expected that in a report that is to be made on this subject a year hence jointly by the Executive Committee and the two committees on Drain Tile and Sewer Pipes, the principles by which it is thought such matters should be governed will be defined.

Mr. Wig. MR. WIG.—Gypsum is similar to cement in that it is not a finished product as it is marketed. There is a Committee on Concrete and Reinforced Concrete which considers proper regulations for the design of reinforced concrete, and I should think the work of Committee C-11, particularly as affecting monolithic gypsum construction, would be analogous. I should like to ask the Secretary what has been the province of the Committee on Concrete and Reinforced Concrete.

THE SECRETARY.—That committee was created for the purpose of cooperating with committees of the American Society of Civil Engineers, the American Railway Engineering Association and the American Association of Portland Cement Manufacturers, to make a broad report on concrete and reinforced concrete. The question of the invasion, by one of its own committees, of a field not directly within the province of this Society does not apply, therefore, in this case. The Secretary.

MR. SPACKMAN.—I want to bring about a broad discussion of this subject. I think that in the particular cases of gypsum, cements, limes and other cementitious materials, it might be very advantageous to the users if this Society should extend its jurisdiction to the methods of use, for the simple reason that none of our tests are made on the materials as purchased, but are made on the materials after they have been mixed into plaster, mortar, concrete, etc. For example, we prescribe a series of standard tests to determine the quality of cement. These tests are all made after the cement has been mixed into mortar. Not only do our specifications prescribe just how much is to be added, but they also prescribe exactly the conditions under which tests are to be made. On seeing the results of these tests, people are apt to draw the conclusion that they are representative of the material in actual use, and that they may expect to get similar results on the work; disregarding the fact that they mix the cement with a sand of an entirely different character and under markedly different surroundings. When the material used fails to give strengths comparable with those obtained in the laboratory, they are disappointed and jump at the conclusion that either the cement is poor, or that our method of testing is wrong. Where we are dealing with raw materials, which, for the purpose of test, are manufactured into finished products, as in the case of cementitious materials, the prescribing of methods of use would appear to be more proper than would be the case with a material which is bought in the condition in which it will be used; but such prescribing of methods of use is opposed to the standard policy of this Society, and I feel that any action looking to the letting down of the bars would not be proper until it has been acted upon by the Society as a whole. Mr. Spackman.

The Secretary. THE SECRETARY.—May I ask first, whether this committee is likely to suffer from lack of work for the ensuing year, if it be not empowered at this time to take up this phase of the work? If it has enough other work for one year, why not wait for the report in prospect a year hence from the joint committee I have previously referred to? In the second place, speaking personally, and not officially, it is difficult to see why exception should be taken to limiting our committees on tests of cementitious materials to defining the methods of testing and the making and mounting of the specimens to be tested. This would seem to provide for doing that which Mr. Spackman appears to think ought to be done, without departing from the long-established policy of the Society. It is a far cry, however, from defining the making of something intended specifically for the purpose of testing, and opening up the field broadly to matters of engineering design and construction.

Mr. Blair. MR. W. P. BLAIR.—It seems to me that it is easy to distinguish between materials and their use. That is where the Society should draw the line. It is easy to distinguish between the testing of a material, and the supervision and testing of the thing made of that material. The limit is clearly defined for every material of construction. I do not agree that a substance which requires assemblage to make it usable should be regarded as an exception to this rule.

Mr. Wig. MR. WIG.—No action is desired at this meeting regarding the work of Committee C-11. It was desired to have some discussion, however. Gypsum may conform to a specification of this Society, but if mixed with water, containing very small quantities of impurities, such as alum, it will not harden properly unless it is manufactured to meet this condition; therefore it would seem desirable that the specifications should cover the finished product made from this material.

Mr. Talbot. PAST-PRESIDENT A. N. TALBOT.—I wonder if Mr. Wig's inquiry is not answered by the name of this committee: "On Gypsum and Gypsum Products"?

Mr. Brown. MR. H. J. BROWN.—It seems to me that a point has been brought out by Mr. Wig which is not being recognized, and that is, the difference between engineering as applied to designing, and the actual use or application of a material. A design may

be proper, and together with the specifications consistent with good engineering practice, but if the materials are improperly used the desired results are not obtained. **Mr. Brown.**

Mr. Wig has brought up the matter of different waters and their action with calcined plaster. The same remarks apply to sand and the aggregate used with wall plaster. Both these matters are recognized in concrete engineering and application, and apply even more to gypsum products, as the latter are far more sensitive to changes in water or aggregate.

It would seem, therefore, that there should be a sharp line drawn between engineering and designing on the one hand, and the use of materials on the other, for in the case of gypsum plaster, for instance, it is analogous to reinforced concrete in that the lathing material acts as a reinforcement in a vertical wall of gypsum.

The fact that gypsum is used in place of Portland-cement concrete should not enter into the discussion.

MR. DOUTY.—I should like to extend my remarks briefly. I spoke with considerable vigor not on account of Mr. Wig's committee, but on account of the suspicion aroused in my mind in glancing through these tile specifications, which seemed to show a tendency that is dangerous. I thoroughly agree that there is common ground between the application of the material and the material itself. As to that common ground, the Secretary has already suggested that we have a means of handling it through joint committee work. **Mr. Douty.**

MR. WIG.—To close the discussion, I would suggest that the committee be permitted to refer the entire matter to the Executive Committee of the Society for consideration. **Mr. Wig.**

THE CHAIRMAN (MR. EDWARD ORTON, JR.).—Such action will be agreeable to the Executive Committee, I am sure. **The Chairman.**

REPORT OF COMMITTEE D-1

ON

PRESERVATIVE COATINGS FOR STRUCTURAL MATERIALS.

Committee D-1, which now has 81 members, has held two meetings during the past year. At the meeting held November 23, 1914, 26 members were present and at the meeting held April 17, 1915, 28 members were present.

Sub-Committee II on Inspection of the Havre de Grace Bridge and Sub-Committee IV on Inspection of Steel Plates at Atlantic City have been discharged, as both tests have been completed and the sub-committees have presented final reports. A special sub-committee has carefully considered the whole history of the Havre de Grace bridge test and presents a report which is believed to give in concise and intelligible form the composition of the paints used and maximum information available from this test.

Another special sub-committee has considered the recommendations made by the Sub-Committee IV on Inspection of Steel Plates at Atlantic City, and as a result of its report, a new sub-committee on Accelerated Tests and the Influence of Paint Materials on Corrosion will be organized.

The committee recommends for submission to letter ballot of the Society for adoption:

1. Proposed Revisions of the Standard Specifications for Purity of Raw Linseed Oil from North American Seed (see Report of Sub-Committee V);

2. Proposed Standard Specifications for Purity of Raw Chinese Wood Oil (see Report of Sub-Committee III);

3. Proposed Standard Specifications for Purity of Boiled Linseed Oil from North American Seed (see Report of Sub-Committee V);

4. Proposed Standard Definitions of Terms Used in Paint Specifications (see Report of Sub-Committee VI);

5. Proposed Standard Specifications for Turpentine (see Report of Sub-Committee XII).

The committee further recommends that the following proposed tentative methods and tests be printed in the Year-Book among the "Tentative Standards" of the Society for one year, with a view of eliciting critical discussion:

1. Proposed Tentative Methods for Routine Analysis of White Pigments (see Report of Sub-Committee VIII);

2. Proposed Tentative Test for Distillation of Paint Thinners other than Turpentine (see Report of Sub-Committee XI);

3. Proposed Tentative Test for Moisture in Bleached Shellac (see Report of Sub-Committee XIII).

Detail reports are appended from the following sub-committees:

Sub-Committee II on Inspection of Havre de Grace Bridge;

Special Sub-Committee on Paints used in Havre de Grace Bridge Tests;

Sub-Committee III on Testing of Paint Vehicles;

Sub-Committee IV on Inspection of Steel Plates at Atlantic City;

Sub-Committee V on Linseed Oil;

Sub-Committee VI on Definitions of Terms used in Paint Specifications;

Sub-Committee VIII on Methods of Analysis of Paint Materials;

Sub-Committee X on Inspection of White-Paint Test Fence at Washington, D. C.;

Sub-Committee XI on Paint Thinners other than Turpentine;

Sub-Committee XII on Turpentine;

Sub-Committee XIII on Shellac;

Special Sub-Committee on Specifications for Sampling of Liquids.

A report of progress has been made by Sub-Committee IX on Varnish.

This report has been submitted to letter ballot of the committee, which consists of 81 members; 48 ballots were cast, 33 not voting. The vote was taken on each section of the report. Following is the result of the ballot:

General report	44	affirmative,	none negative.
Report of Sub-Committee II	40	"	" "
" " Special Sub-Committee on Havre de Grace Bridge Tests	54[a]	"	" "
" " Sub-Committee III	42	"	" "
" " " " IV	43	"	" "
" " " " V	42	"	" "
" " " " VI	42	"	2 "
" " " " VIII	39	"	none "
" " " " X	43	"	1 "
" " " " XI	41	"	1 "
" " " " XII	37	"	4 "
" " " " XIII	39	"	none "
" " Special Sub-Committee on Sampling of Liquids	39	"	" "

[a] The vote on this item was taken after the presentation of the report at the annual meeting, and resulted in the casting of 54 affirmative ballots.—ED.

Respectfully submitted on behalf of the committee,

P. H. WALKER,
Chairman.

G. W. THOMPSON,
Secretary.

[EDITOR'S NOTE.—In presenting this report at the annual meeting, Committee D-1 recommended certain amendments, which are given on pages 25–27. For action taken on the report as amended, see pages 25–27.

The proposed amendments in the Standard and the four proposed Standards referred to in the report, as amended at the annual meeting, were adopted by letter ballot of the Society on August 21, 1915. The Standards as thus amended appear among the Standards in the 1915 Year-Book.

The proposed Tentative Standards referred to in the report, as amended at the annual meeting, appear among the Tentative Standards in the 1915 Year-Book.

For Discussion on the report, see page 270.]

REPORT OF SUB-COMMITTEE II ON INSPECTION OF HAVRE DE GRACE BRIDGE.

In accordance with a resolution of Committee D-1, upon recommendation of Sub-Committee II in its last report, to discontinue the inspection of the Havre de Grace bridge, and to discharge this sub-committee upon the proper disposition of the test plate panels, on December 4, 1914, following action of the Advisory Committee of Committee D-1 authorizing such disposition, one complete set of these plate panels, 57 in all—three for each of the 19 paints, one each at the several spreading rates of 600 sq. ft., 900 sq. ft. and 1200 sq. ft. per gallon of paint—were removed from the bridge site and delivered to the U. S. Bureau of Standards and one complete set to the Institute of Industrial Research at Washington, D. C. The remaining panel plates, 38 in all,—2 for each of the 19 paints, one each at the two spreading rates of 600 sq. ft. and 1200 sq. ft. per gallon of paint,—were delivered to the laboratory of the National Lead Co., 129 York St., Brooklyn, N. Y., in care of Mr. G. W. Thompson, Secretary of Committee D-1, 19 plates—one for each of the paints at the spreading rate of 900 sq. ft. per gallon of paint—having been utilized by the committee several years ago, as reported at the time, in an investigation of the condition of the metal after removal of the paints on these particular plates. These plates are in storage and cared for at the laboratory of the National Lead Co.

On December 18, 1914, Mr. H. R. Leonard, Engineer of Bridges of the Pennsylvania Railroad Co., Philadelphia, was officially notified and such notification acknowledged by him, of the conclusion of the test by Committee D-1, and that the structure had been turned over to the railroad company from that date with the thanks of the committee.

Respectfully submitted on behalf of the sub-committee,

W. A. AIKEN,
Chairman.

REPORT OF SPECIAL SUB-COMMITTEE ON PAINTS USED IN HAVRE DE GRACE BRIDGE TESTS.

The special sub-committee, to which was referred the motion made at the last annual meeting of the Society charging Committee D-1 to renew its efforts to obtain such additional information as would enable the committee to describe the composition of the several paints of the Havre de Grace bridge tests more satisfactorily to the engineering profession, than could be interpreted from the committee's published analyses, and also to compile a brief résumé of the methods and conditions of the test, reports as follows:

Under date of November 20, 1914, a circular letter was sent to each of the manufacturers who furnished paints for the Havre de Grace bridge tests. This letter referred to the continued demand for fuller information as to the composition of the paints, and for an identification of the manufacturers' names with the paints tested. Two inquiries were made of each manufacturer, namely: (1) "Would you object to Committee D-1 reporting to the Society that panels and section Nos. — were painted with paint furnished by you?"; and (2) "It is our plan to publish a brief description of your paint, such description to be based either upon the analysis which we have made, or upon information received from you. Would the following description of your paint be satisfactory?"

The letter also requested "that if the enclosed description is not satisfactory, please send one that is," adding that information of value to engineers was desired. Furthermore, there was enclosed to each manufacturer a blue-print "log," giving the record of the particular paint as applied, with a statement that copy of this had been sent originally upon completion of the painting of the bridge, and that such record was to be published by Committee D-1.

The receipt of this letter was acknowledged by all but two of the contributing manufacturers. Of those who acknowledged

the receipt of the letter, the manufacturers of nine paints were willing to have their names published in connection with the paints. The manufacturers of six paints were unwilling, and the manufacturers of two paints did not reply to this specific inquiry. The manufacturers of seven paints accepted the sub-committee's description without suggesting modifications. Ten suggested modifications.

Appended to this report are the sub-committee's descriptions of the paints, and such descriptions as have been suggested by manufacturers; also, the "log" sheets referred to (Plates III to XXI, inclusive).

The objections of the manufacturers of six paints to the publication of their names in connection with the paints makes it impossible for the sub-committee in good faith to publish any information relating thereto.

BRIEF RÉSUMÉ OF THE METHODS AND CONDITIONS OF THE TESTS.

The report of Committee D-1 for 1906 gives the information as to its previous preliminary work leading up to the inception of the Havre de Grace bridge tests through report and recommendation of a Sub-Committee on Field and Service Tests, and makes note of the courtesy of the Pennsylvania Railroad Co. in placing at the committee's disposal such parts of the new bridge over the Susquehanna river as would be required. The report gives the copy of the committee's circular letter to the paint manufacturers of the country, in which their cooperation is invited in the proposed exposure test under practical field conditions, together with a statement of the probable pro-rata cost under different areas painted and varying numbers participating in the test, with the statement that "the Society has no funds available for the trial and it will be necessary for the manufacturers to make a deposit sufficient to cover their share of the expenses." A general statement of the conditions under which the tests are to be developed is given with the further information that the details of conducting the tests are to be determined by the committee and framed to be "eminently fair to each competitor and to the paints themselves."

Satisfactory replies to the original circular letter having

been received from a sufficient number of manufacturers to warrant the inauguration of the test, costs were figured on an area basis and a second circular letter sent to those who had agreed to enter the competition, the most important point involved being the following questions propounded, covering the composition and proportioning of the materials of each paint:

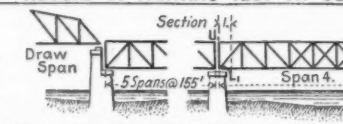
Pigment;
Volatile thinner;
Vehicle or liquid non-volatile matter, particular information being desired as to the following:
1. Saponifiable oils, that is, linseed, etc.;
2. Resinous matter—that is, resins and gums;
3. Bituminous matter, that is, asphaltum, pitch, etc.;
Mineral matter such as lead, manganese, lime, etc., other than that present as pigment.

Unfortunately these questions were regarded as too searching by many paint manufacturers on the ground that if answered they would disclose trade secrets and methods of manufacture. since the committee had stated that in formulating the above list of questions the information sought was not intended to include trade secrets or particular methods of treatment or manufacture of the constituents of the paints.

In view of the attitude of the manufacturers, and to avoid the complete jeopardizing of the proposed tests, the above questions were specifically withdrawn and only such information as the manufacturers were willing to submit was asked for. This, coupled with that to be derived from the duplicate analyses of each paint by the committee, comprised all the data accumulated whereon to base descriptions of the paints such as are desired by the large engineering membership of the Society.

It must be understood that the committee fully recognized, as soon as the manufacturers refused the fullest information regarding their paint products, that a considerable part of the anticipated value of these ests would not be realized. Appreciating as time went on during the annual inspections, that the action of certain paints might be more intelligently interpreted with fuller detailed information not in the possession of the com-

RECORD OF PAINTING TEST ON SE



Paint was Applied only when Humidity was 85 or less.

	Date '06.	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered
										gal.	lb.	sqft	sq.ft.
1st Coat	July 13		2^19 to 5^57	Clear	55	53	80	79					
	" 14		7^52 to 10^55	"	80	71	79	66					
	Aug. 6		12^24 to 5^09	"	74	70	90	87					
	" 7		9^26 to 5^09	"	83	68	85	79					
	" 8	About 11^32 to 12^19		"	74		81^2						
		200							57^19	9.6	11.27	424	4070
2nd Coat	Sept. 17		0	Fair	84	72	73	61	0	0			
	" 18		9^28 to 5^38	"	90	84	77	69	34	4.81			
	" 19		10^21 to 4^18	"	95	77	82	73	15	2.28			
	" 20		0	Cloudy	95	80	81	73	0	0			
	Totals								49	7.09	9.164	568	4028
3rd Coat	Oct. 1		A.M.	Cloudy	83	70	58	52		0.13			

Remarks: – Color, bright red with luster. Pric
the paint was found in fine condition. It was in
also free from settlement. The painters said it w
much time was wasted in retouching. It set quick
The inside surface of posts P and P' (See diagr
covered with a shop coat of red lead which was
The south side surface of P' and the north sid
cleaned. The south side surface of the upper s
over the rust. It was removed easily and well
Swabs were used under the ends of lacing
parts were painted with standard round brush

Weather record is from 7^30 A.M. to 5 P.M. only.
Top work & panel half down.
Completed panel and bottom work and chairs.
Foreman's time omitted.

Paint received June--/06
Color, Black with slight m
Price ------- per gallon.
Sept. 17, opened ½ bbl. foun
no separation. A good stiff
easily. Sets in 24 hr.
Oct. 13, shows a good gloss,
post where a rain from sho
A little Red Lead paint was
post and braces by men on

On north chair to cover Red Lead spilled by men on next span west. Applied by foreman.

No 3rd coat on this section
to cover Red Lead paint spille

Oct. 13. Except spatters of Re
on next span west, this se
(medium thin) body of paint
Shower of Oct. 20 left wate
outside of south batter pos

SEC. No. 1.

Note: Test Plates in Triplicate. 3 for each Spreading Rate. Max. Temp. is for the Paint Room. Min. " " from Daily Outside Record. Humidity " " " "

RECORD OF PLATE TES

FIRST COAT
Weight per gal. 11.27 lb.
Specific Gravity 1.35

Spreading Rate of 1200 Sq. Ft. per Gallon.

Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used a.	Paint Used gal.
1	July 18	90°	—	—	—	24 hr.	25.56	1/200
2	" "	"					"	"
3	" "	"					"	"

This Paint Spreads Best at 900 Sq. Ft. per Gallon.

Spreading Rate o

Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	H M
1	July 18	90°	—	—
2	" "	"		
3	" "	"		

SECOND COAT
Weight per gal. 9.164 lb.
Specific Gravity 1.10

Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used a.	Paint Used gal.
1	Sept. 18	70°	69°	90	84	24 hr.	20.79	1/200
2	" "	"	"	"	"	22 "	"	"
3	" "	"	"	"	"	24 "	"	"

This Paint Spreads Best at 1200 Sq. Ft. per Gallon.

Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	H M
1	Sept. 18	70°	69°	9
2	" "	"	"	
3	" "	"	"	

THIRD COAT
Weight per gal. 9.300 lb.
Specific Gravity 1.12

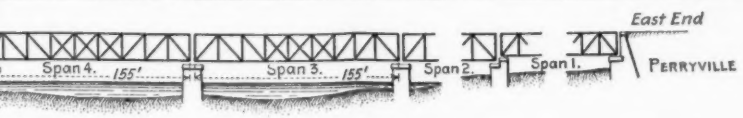
Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used a.	Paint Used gal.
1	Oct. 2	62°	56°	88	71	24 hr.	21.19	1/250
2	" "	"	"	"	"		"	"
3	" "	"	"	"	"		"	"

This Paint Spreads Best at 1200 Sq. Ft. per Gallon.

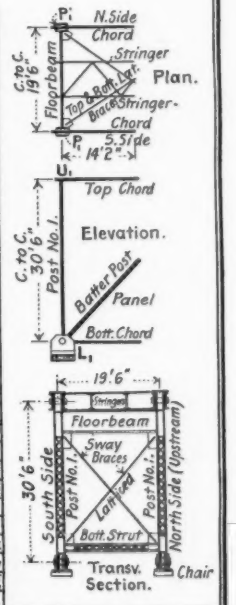
Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	H M
1	Oct. 2	62°	56°	8
2	" "	"	"	
3	" "	"	"	

PLATE III.
PROC. AM. SOC. TEST. MATS.
VOL. XV, PART I.
REPORT OF COMMITTEE D-1:
HAVRE DE GRACE BRIDGE TESTS.

TEST ON SECTION NO. 1.



luster. Price $1.50 per gal. in bbl. July 9, 1906. On opening barrel . It was in good suspension, though heavy and hard to stir, and ters said it was tiresome to brush out and fill cracks with it, and It set quickly and dried in two days.
P, (See diagram to the right) were badly rusted and had been which was loose and peeling off. It was fairly well cleaned. he north side surface of P, were badly rusted but well he upper south and north chords had a coat of black oil y and well cleaned.
s of lacing bars and between bottom chord bars. All other ound brushes.



June--'06 in ¼ bbl.	This coat applied to all surfaces
ith slight maroon tint.	except top side of floor system
r gallon.	which was painted Red Lead before
d ½ bbl. found no settlement and	track was laid.
A good stiff body but brushes out	Same kind of brushes were used
in 24 hr.	as for 1st coat.
a good gloss, except on south batter	
ain from shower Oct. 19 shows slightly.	Surfaces that were not accessible
ad paint was spattered on the end	for wire brushes are omitted from
es by men on next span.	test comparison.
this section except on North chair	Red Lead was used in the construc-
ad paint spilled by men on next span.	tion work inside the box latticed
spatters of Red Lead by R.R. Co's. men	girders and posts and under the
west, this section shows a good even	floorbeam and stringer flange and
body of paint with good gloss.	stiffener angles also on the post
20 left water marks on the top and	pin connections and inside the chairs.
th batter post.	The shop coat of black is soft in warm
	weather but could not be scraped off,
	especially truss bars and floorbeams.

PLATE TESTS.

Nov. 1 to 3, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36"x 24"x ⅛"± (No. 10 Gage), Weight 35 lb. ±

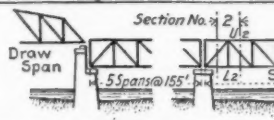
Spreading Rate of 900 sq. ft. per Gallon.

Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
90°	—	—	—	36 hr.	34.08	1/30
"				" "	"	"
"				" "	"	"
70°	69°	90	84	36 hr.	27.72	1/30
"	"	"	"	" "	"	"
"	"	"	"	" "	"	"
62°	56°	88	71	36 hr.	28.55	1/30
"	"	"	"	" "	"	"
"	"	"	"	" "	"	"

Spreading Rate of 600 sq. ft. per Gallon.

Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
1	July 18	90°	—	—	—	48 hr.	51.12	1/20
2	" "	"				" "	"	"
3	" "	"				" "	"	"
1	Sept. 18	70°	69°	90	84	48 hr.	41.58	1/20
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Oct. 2	62°	56°	88	71	48 hr.	42.28	1/20
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST



Paint was applied when the humidity was 85 or less.

	Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
										gal.	lb.	sq.ft.	sq. ft.	
1st Coat	July 14		12[30] to 1[30]	Clear	53	49	81	75	9					Remarks:- Color, black. Price $1.25 per g
	" 16		7[30] to 10[30]	Cloudy	86	83	74	71	3					condition on opening barrel. It had sett
	Aug. 6		12[30] to 5[00]	Clear	74	70	90	87	9					but had to be continually stirred to keep
	" 7		9[00] to 11[30]	"	83	68	83	79	3					Rain seemed to wash it off when not thoro
	" 8		10[30] to 2[00]	Fair	74	81	75	77	4					The south outside surfaces of both sou
	" 9		10[00] to 5[00]	Cloudy	82	78	76	75	7					under the covering of black oil. The latter
	" 10		8[00] to 4[00]	Clear	84	70	81	72	5					of these chords were well cleaned. The nor
		11	24						56	40	12.3	982	380	4675	fairly cleaned. The east outside surface
															Manhelpers were used inside of the east
															lacing bars and between bottom chord ba
															brushes were used.
2nd Coat	Sept. 17		0	Fair	84	72	73	61	0	0				Weather record is from	Paint received June
	" 18		6[30] to 9[00]	"	90	84	77	69	13	50	3.16			7[30] A.M. to 5 P.M. only.	Color Black (Dull) Pric
	" 19		10[45] to 5[00]	"	95	77	82	73	15	00	2.37			West panel half way down.	Sept. 17 opened ½ bbl.
	" 20		8[15] to 3[30]	Cloudy	95	80	81	73	18	50	2.83			" " to chord & top of E. panel.	ture with slight sepe
	" 21		0	Clear	86	52	84	72	0	0				Section completed.	This paint brushes ou
	Totals								47	00	8.36	9810	553	9628	hrs. is quite firm in 4
														Foremans time omitted.	Note: A shop coat of Red Lea
															under flange and stiffener an
3rd Coat	Sept. 30		Sunday	Cloudy	71°		67°		0	0					Paint received June
	Oct. 1		8[00] to 5[00]	"	83	70	58	52	11	00	2.00			West panel to bottom strut.	Color, Black, (Brown tint)
	" 2		9[00] to 11[30]	"	88	71	67	56	8	00	0.97			" " completed & top outsides	Sept. 29 opened ½ bbl.
	" 3		0	Fair	78	59	70	61	0	0				Staging held for No. 3 paint to come	in bottom that was e
	" 4		0	Rain Storm	95	95	66	63	0	0				" " " " " " "	working conditions a
	" 5		0	Fair	95	67	74	64	0	0				" " " " " " "	with 2nd coat
	" 6		0	Showers	92	90	68	66	0	0				" " " " " " "	Oct. 2. spilled about a
	" 7		Sunday	Fair	44		61		0	0				Sunday	top (northside) of floor
	" 8		11[30] to 5[00]	Clear	71	46	60	45	9	50	1.01			East panel top and floor beam	was set. The surface
	" 9		7[30] to 10[30]	Fair	87	69	70	57	5	50	0.73			" " down to bottom chord	but leaves a poor sur
	" 10		10[00] to 11[00]	"	76	53	53	42	1	50	0.21			" " bottom chord	floor beam.
	" 11		0	"	82	40	47	38	0	0				Completed 11 A.M. Oct. 10.	Work on 3rd. coat delaye
	Totals								35	50	4.92	9818	809	3980	as men on panel stagi
														Foremans time omitted.	

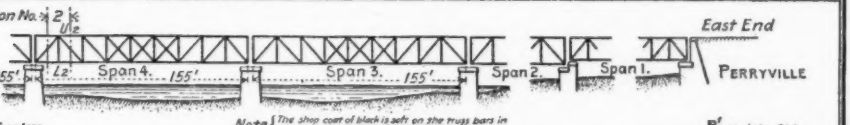
Note: Test Plates in Triplicate, 3 for each Spreading Rate.
Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record.
Humidity " " " "

SEC. No. 2.. RECORD OF PLAT

Spreading Rate of 1200 sq ft per Gallon.

	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used q.	Paint Used gal.	Plate No.	Date 1906	Temp., Max.	Spreading R
FIRST COAT Weight per gal. 9.82 lb. Specific Gravity 1.18	1	July 18	90°				24 hr.	22.27	1/50	1	July 18	90°	
	2	" "	"				" "	"	"	2	" "	"	
	3	" "	"				" "	"	"	3	" "	"	
	This Paint Spreads Best at 1200 sq ft per Gallon.												
SECOND COAT Weight per gal. 9.836 lb. Specific Gravity 1.18	1	Sept 18	79°	69°	90	84	24 hr.	22.31	1/50	1	Sept. 18	79°	
	2	" "	"	"	"	"	" "	"	"	2	" "	"	
	3	" "	"	"	"	"	" "	"	"	3	" "	"	
	This Paint Spreads Best at 1200 sq ft per Gallon.												
THIRD COAT Weight per gal. 9.878 lb. Specific Gravity 1.19	1	Oct. 2	62°	56°	88	71	24 hr.	22.45	1/50	1	Oct. 2	62°	
	2	" "	"	"	"	"	" "	"	"	2	" "	"	
	3	" "	"	"	"	"	" "	"	"	3	" "	"	
	This Paint Spreads Best at 1200 sq ft per Gallon.												

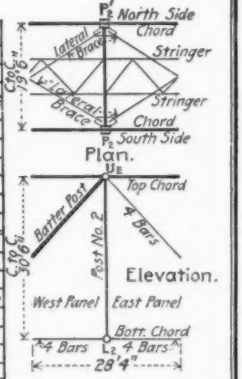
TING TEST ON SECTION No. 2.



or less.

Note { The shop coat of black is left on the truss bars in warm weather but could not be scraped off.

ice $1.05 per gal. in bbl. April 20, 1906.– This paint was found in good
It had settled somewhat, but stirred up easily. It worked freely,
red to keep from settling, which the men would forget to do.
en not thoroughly dry, particularly at the edges of horizontal surfaces.
of both south and north chords (west half of section) were badly rusted
l. The latter was easily removed with sharp ship scrapers. The sides
d. The north outside surface of post P_2 was badly rusted but
ide surface of post P_2 was poorly cleaned.
e of the east half of top chords. Swabs were used at the ends of all
m chord bars and diagonal bars. All other parts standard pound



eived June /06 in ½ barrels.	
ck (Dull) Price per gal.	This coat applied to all accessible surfaces
opened ½ bbl. medium heavy mix-	except the top sides of floor system
th slight seperation but easily stirred in.	which were painted Red Lead before the
nt brushes out easily and dries in 20	track was laid.
uite firm in 48 hrs.	Brushes used were same kind as for 1st.
e coat of Red Lead was put inside top chords and	coat.
ge and stiffener angles of floor beams and in post pins	
ceived June /06 in ½ barrels.	This coat applied to same surfaces as
ck (Brown tint) Price per gal.	2nd. coat except omitted from the in-
opened ½ bbl. a slight pasty settlement	sides of top chord box (latticed) girder
n that was easily dissolved. The	and no long handle brushes used.
conditions are about the same as	Sheepskin swabs were used in the nar-
d coat	row places between bars and these sur-
pilled about a quart of this paint on the	faces are to be omitted from the test
hside) of floorbeam before the paint	comparisons. Round 1 lb. brushes on all
The surface was wiped and rebrushed	other surfaces
es a poor surface on west side of the	Oct 13. this section shows an even coat
rm.	(except on floor beam) fairly well brushed
3rd. coat delayed for arrival of Sec. 3 paint	out except on ends of lattice bars of North
n panel staggings work two adjoining sections	post. The color a greyish black, not much gloss.

Nov. 1 to 3, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

RD OF PLATE TESTS.

Spreading Rate of 900 sq. ft. per Gallon.

Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used g.	Paint Used gal.
uly 18	90°				24 hr.	29.69	1/50
" "	"				" "	"	"
" "	"				" "	"	"
ept. 18	79°	69°	90	84	24 hr.	29.74	1/50
" "	"	"	"	"	" "	"	"
" "	"	"	"	"	" "	"	"
ct. 2	62°	56°	88	71	24 hr.	29.92	1/50
" "	"	"	"	"	" "	29.93	"
" "	"	"	"	"	" "	"	"

Spreading Rate of 600 sq. ft. per Gallon.

Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used g.	Paint Used gal.
1	July 18	90°				24 hr.	44.53	1/100
2	" "	"				" "	"	"
3	" "	"				" "	"	"
1	Sept 18	79°	69°	90	84	24 hr.	44.62	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Oct. 2	62°	56°	88	71	24 hr.	44.90	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST

HAVRE DE GRACE — Draw Span — 5 Spans @ 155'

Section N

Paint was applied where humidity was 85 or less.

	Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Am't. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
										gal.	lb.	sq. ft.	sq. ft.	
1st Coat	Aug. 8		11[25] to 12[55]	Cloudy	83	74	81	80						Remarks:- Color, lustrous black.- Price
	" 9		10[05] to 05[50]	"	82	78	76	75						suspension on opening barrel. It stir
	" 10		8[25] to 4[25]	Clear	84	70	81	725						The painters on bridge called it the c
	" 11		9[25] to 4[25]	"	84	74	86	785						would not take the time to brush it out c
	" 14		8[50] to 5[10]	"	84	67	82	728						and dry in a day. It needed no stirring
	" 15		10[20] to 12[25]	"	58	79	58	78						on horizontal surfaces.
		106[15]							59.10	173	183	206.4	4940	The south outside surface of north c
														cleaned. The south side of south stringer(e
														outside surface of post P[3] was badly
														south sides(east half of section) were b
														inside of top chords, swabs at ends of lattice
2nd Coat	Sept. 18		0	Fair	90	84	77	69	0	0				(Weather record is from 7[30] A.M. to 5 P.M. only. — Paint received June
	" 19		10[45] to 05	"	95	77	82	73	19.50	3.34				Top chords, stringers & fl'beam. — Color Light Gray
	" 20		9 to 5	Cloudy	95	80	81	73	18.50	3.32				Both panels & top outsides — Sept. 17[th] opened 5 ga
	" 21		8 to 3	Clear	86	52	84	72	13	0.94				Bottom work completed. — Settlement in bottom
	" 22		0	Cloudy	93	72	81	70	0	0				Sec. completed 3 P.M. 21[st]. — This paint brushes out
	Totals								51.	7.60	8.39	6.46	1891	Foreman's time omitted. — applied carefully and
														Dries quickly, quite
3rd Coat	Oct. 7		0	Fair	44		61	0	0					Paint received Oct. 8
	" 8		11[25] to 05	Clear	71	46	60	45	10.	1.74				Sunday — Color Dark Brown
	" 9		7[14] to 04	Fair	87	69	70	57	18.50	3.27				Top of west panel & fl'beam — Opened 5 gal. kit Oc
	" 10		8 to 2[15]	"	96	53	53	42	7.50	1.64				Both panels & top outsides — conditions same as
	" 11		0	"	82	40	47	38	0.	0.				Bot'of E. panel & Bot' chords etc. — an even surface wi
	Totals								36.	6.65	19.0	6.13	4073	Foreman's time omitted. — Oct. 13[th] shows an e
														There are indicatio
														3[rd] coat on west p
														on the inside.

SEC. No. 3.

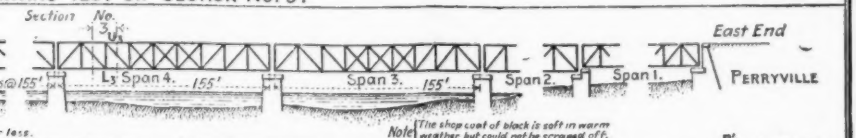
Note: Test Plates in Triplicate. 3 for each Spreading Rate.

Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record
Humidity " " " "

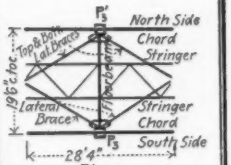
RECORD OF PL

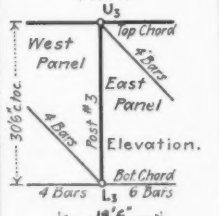
	Plate No.	Date 1906	Temp., Fahr. Max.	Min.	Humidity Max.	Min.	Time read to Dry	Paint Used gal.	gal.	Plate No.	Date 1906	Tem Max.
			Spreading Rate of 1200 sq ft per Gallon.									Spreadin
FIRST COAT Weight per gal. 7.830 lb Specific Gravity 0.94	1	Aug. 7th	88°	68°	83°	68°	3 hours	17.16	1/200	1	Aug. 7th	88°
	2	" "	"	"	"	"	" "	"	"	2	" "	"
	3	" "	"	"	"	"	" "	"	"	3	" "	"
	This Paint Spreads Best at 900 sq ft per Gallon.											
SECOND COAT Weight per gal. 15.399 lb Specific Gravity 1.85	1	Sept. 20	76°	73°	95	80	24 hours	34.95	1/200	1	Sept. 20th	76°
	2	" "	"	"	"	"	" "	"	"	2	" "	"
	3	" "	"	"	"	"	" "	"	"	3	" "	"
	This Paint Spreads Best at 600 sq ft per Gallon.											
THIRD COAT Weight per gal. 11.923 lb Specific Gravity 1.31	1	Oct. 8th	68°	45°	71	46	48 hours	27.05	1/200	1	Oct. 8th	68°
	2	" "	"	"	"	"	24 "	"	"	2	" "	"
	3	" "	"	"	"	"	" "	"	"	3	" "	"
	This Paint Spreads Best at 900 sq ft per Gallon.											

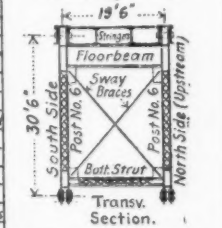
INTING TEST ON SECTION No. 3.



Note The shop coat of black is soft in warm weather but could not be scraped off.







lack.– Price $0.90 per gal. in bbl.– This paint was found in good rrel. It stirred easily and had no settlement at bottom of barrel. ed it the coal tar paint. It was thick and set so quickly, that the men rush it out and it would sag. It set within 2 hours, and became hard no stirring on the work. A slight shower on the fresh paint pitted it	
e of north chord (east half of section) was badly rusted, but well th stringer (east half of section) was badly rusted, but well cleaned. The north was badly rusted, but well cleaned. The 2nd diagonal bars both north and or) were badly rusted, but fairly well cleaned. Manhelpers were used ds of lattice bars and between bot chord and diag. bars, lb. brushes on other parts	
eceived June /06 in 5 gal. kits ight Gray Price-------- per gallon. st opened 5 gal. kit, found a little pasty ent in bottom of kit that was easily dissolved. t brushes out to a medium heavy even coat if carefully and properly brushed out. ickly, quite firm in 24 hr.	Same kinds of brushes used as for 1st coat and was applied to same surfaces. No paint applied to top of floor system as this was painted Red lead before the track was laid. The inside surfaces not accessible for wire brushes are not to be included in the test comparison.
eceived Oct. 8th/06 in 5 gal. kits ark Brown Price----- per gallon 5 gal. kit Oct. 8, found the working ns same as 2nd coat. Dries in 40 hr. with surface with a good gloss.	Brushes used same kind as on 1st coat except no long handle manhelpers as this coat was omitted from inside of top chord which rec'd a coat of Red lead in construction.
shows an even coat fairly well brushed out. are indications of grease spatters under the t on west panel down stream track stringer inside.	Red lead was also used at shop under the flange and stiffener angles of stringers and floor beams and in the post pin connections.

CORD OF PLATE TESTS.

Nov. 1 to 3, 06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x 1/8" ± (No. 10 Gage), Weight 35 lb. ±

Spreading Rate of 900 sq" per Gallon.									Spreading Rate of 600 sq" per Gallon.									
Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.	
1	Aug. 7th	88°	68°	83	68	3 hours	23.68	1/150	1	Aug. 7th	88°	68°	83	68	3 hours	35.52	1/100	
2	" "	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"	
3	" "	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"	
	Sept. 20th	76°	73°	95	80	24 hours	46.57	1/150	1	Sept. 20th	76°	73°	95	80	24 hours	69.86	1/100	
	" "	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"	
	" "	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"	
	Oct. 8th	68°	45°	71	46	48 hours	36.06	1/150	1	Oct. 8th	68	45	71	46	48 hours	54.10	1/100	
	" "	"	"	"	"	42 "	"	"	2	" "	"	"	"	"	" "	53.10	"	
	" "	"	"	"	"	48 "	"	"	3	" "	"	"	"	"	" "	54.10	"	

RECORD OF PAINTING TEST

Section No

Paint was applied when humidity was 85 or less.

	Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	Remarks
1st Coat	Aug. 11		9[30] to 4[00]	Clear	84	74	86	79		gal.	lb.	sqft	sq ft.	Remarks:– Color, black.–Price $0.90 pe
	" 14		8[00] to 4[30]	"	84	67	82	72.8						easily, and was in good suspension.
	" 15		12[30] to 5[30]	Cloudy	61	54	81	79.5						It was thin and worked easily and nee
	" 16		9[00] to 3[30]	Clear	84	72	81	74						fully drying in two days, and had a fa
	" 17		9[00] to 3[45]	"	82	64	83.5	75						The south outside surface of north
	" 18		8[00] to 9[00]	Cloudy	84	74	74	73						cleaned. The south side of south stringe
		9h.10							48.30	13.0	8.01	391	5080	The south surface of north stringer (eas
														diagonal bars, both north and south side
														cleaned.
														Manhelpers were used inside of top c
														bottom chord bars and diagonal bars. All
2nd Coat	Sept. 18		0	Fair	90	84	77	69	0	0				Weather record is from 7[30] A.M. to 5 P.M. only
	" 19		8[00] to 5[00]	"	95	77	82	73	8.00	1.74				West panel top work & fl. beam
	" 20		8[00] to 5[00]	Cloudy	95	80	81	73	17.50	3.39				Both panels to bottom chord
	" 21		8[00] to 5[00]	"	86	52	84	72	4.00	1.47				W. panel bot. chord & top outsides
	" 22		9[30] to 11[30]	"	93	72	81	70	4.00	0.68				E. panel bot. chord & strut
	" 23		Sunday	Clear	71		73		0	0				Weather record for 9[30] A.M.
	Totals								33.50	7.28	8.11	3.91	5031	Formans time omitted
	Oct. 1		0	Cloudy	83	70	58	52	0	0				
	" 2		9[30] to 3[45]	"	88	71	67	56	13.00	1.60				East top work & panel
	" 3		12[30] to 1[15]	Fair	78	59	70	61	2.50	0.68				" panel bottom chord
	" 4		0	Rain Storm	95	95	66	63	0	0				
	" 5		Noon	Fair	95	67	74	64	0.75	0.14				Top outsides
	" 6		0	Showers	92	90	68	66	0	0				Staging held for No. 3 paint to arrive
	" 7		0	Fair	44		61		0	0				" " " " " " "
	" 8		0	Clear	46	71	60	45	0	0				" " " " " " "
	" 9		10[30] to 4[45]	Fair	87	69	70	57	10.50	1.28				W. panel top & half down
	" 10		9[30] to 9[45]	"	96	53	53	42	4.50	0.87				" " bottom half & chords
	" 11		2[15] to 3[45]	"	82	40	47	38	0	0				
3rd Coat	Totals								31.25	4.57	8.06	3.22	4213	Foreman's time omitted

Paint received
Color, Black
Sept. 18. opene
siderable separa
three days to g
begin to set un
surfaces (inside
days. There ma
the surfaces

Paint received
Oct. 1. opened
Color, Black
Appearance o
conditions se
dries more q
quite firm in

SEC. No. 4.

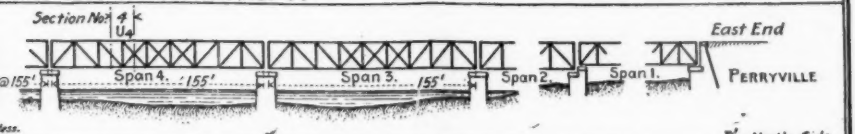
Note: Test Plates in Triplicate. 3 for each Spreading Rate.
Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record.
Humidity " " " " "

RECORD OF PL

	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used q.	Paint Used gal.
			Spreading Rate of 1200 sq ft per Gallon.						
FIRST COAT Weight per gal. 8.01 lb. Specific Gravity 0.96	1	Aug. 14	86°	72°	84	67	24 hr.	18.17	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.								
SECOND COAT Weight per gal. 8.113 lb Specific Gravity 0.97	1	Sept. 20	86°	73°	95	80	24 hr.	18.40	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint had to be flowed on for 1200 sq ft per Gallon.								
THIRD COAT Weight per gal. 8.130 lb Specific Gravity 0.98	1	Oct. 2	72°	56°	88	71	36 hr.	18.44	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint had to be flowed on for 1200 sq ft per Gallon.								

	Plate No.	Date 1906	Temp. Max.
	Spreading		
	1	Aug. 14	86°
	2	" "	"
	3	" "	"
	1	Sept. 20	86°
	2	" "	"
	3	" "	"
	1	Oct. 2.	72°
	2	" "	"
	3	" "	"

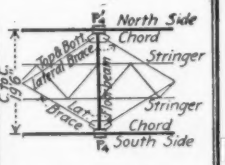
NTING TEST ON SECTION No. 4.

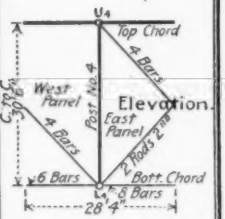


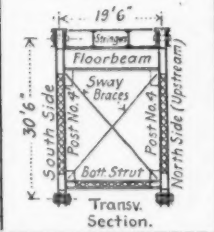
ess.

Price $0.90 per gal. in bbl.—This barrel of paint had no settlement, stirred
pension.
sily and needed no stirring on the work. It also set rather quickly,
d had a fair luster. A shower on the fresh paint pitted its top surface.
ace of north chord (west half of section) was badly rusted but well
outh stringer (west half of section) was badly rusted but well cleaned.
tringer (east half of section) was badly rusted but well cleaned. The 2nd
d south sides (west half of section) were badly rusted but fairly well

ide of top chord, swabs at the ends of all lacing bars and between
nal bars. All other parts were painted with standard round pound brushes.







aint received June--/06 in ½ barrels olor, Black Price per gallon pt. 18. opened ½ bbl. An even mixture, no con- derable separation, easily applied, and dries in ree days to quite firm coat, good gloss. Did not gin to set until after 48 hr., and some vertical rfaces (insides of track stringers) wet three ys. There may have been grease spatters on e surfaces of insides of track stringers.	This coat applied to same surfaces as 1st coat. No paint applied to topside of floor system as that was painted Red Lead before track was laid. Brushes used were same kind as on 1st coat. Surfaces not accessible for cleaning with wire brushes are not to be considered in the test.
aint received June--/06 in ½ barrels t. 1. opened ½ bbl. olor, Black. Price ---------- per gallon. ppearance of mixture and the working nditions same as 2nd coat except it ries more quickly. Sets in 12 to 20 hr., uite firm in 72 hr.	This coat applied to same surfaces as 2nd coat except omitted from insides of top chord lattice girders. No long handle brushes used. Shop coats of Red Lead were put inside the box girder of top chord and under the flange and stiffener angles of the floor-beams and stringers, also in making the post pin connections.

Nov. 1 to 3, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

ORD OF PLATE TESTS.

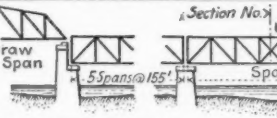
Spreading Rate of 900 sq. ft. per Gallon.

Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
Aug. 14	86°	72°	84	67	36 hr.	24.23	1/100
" "	"	"	"	"	" "	"	"
" "	"	"	"	"	" "	"	"
Sept. 20	86°	73°	95	80	36 hr.	24.53	1/100
" "	"	"	"	"	" "	"	"
" "	"	"	"	"	" "	"	"
Oct. 2.	72°	56°	88	71	60 hr.	24.58	1/100
" "	"	"	"	"	" "	"	"
" "	"	"	"	"	" "	"	"

Spreading Rate of 600 sq. ft. per Gallon.

Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used q.	Paint Used gal.
1	Aug. 14	86	72	84	67	36 hr.	36.34	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Sept. 20	86°	73°	95	80	36 hr.	36.80	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Oct. 2	72°	56°	88	71	60 hr.	36.88	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST ON



Paint was applied only with humidity at 85 or less.

	Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	Remarks
										gal.	lb.	sq. ft.	sq. ft.	
1st Coat	Aug. 15		3[30] to 5[15]	Cloudy	61	54	81							Remarks, — Color, black. — Price $1.25 per ga
	" 16		9[25] to 3[30]	Clear	84	72	81	72.5						heavy on opening, but stirred up easily and
	" 17		9[8] to 1[30]	"	82	64	83½	74						In the application of this paint the work
	" 18		8[30] to 10[15]	Cloudy	84	76	73							of its thickness and heaviness. It set slowly
	" 20		9[25] to 12[15]	"	85	76	83	78.5						touch. It also skinned easily.
	" 21		11[0] to 5[30]	Fair	81	84	82	80						The south surface of north stringer (we
	" 22		9[30] to 2[45]	Clear	78	76	82	76.5						The bottoms of both top chords and stringers
	" 23		9[25] to 4[0]	"	85	76	83	78.5						The upper lateral braces (east half of section) w
	" 24		12[15] to 7[30]	Cloudy	84		72	68						Manhelpers were used on the inside surfaces
		115.50							65.00	18.1	10.41	3.17	5740	bars and between bottom chord bars and diag
														pound brushes.
2nd Coat														Paint received June /
	Sept. 19		0	Fair	95	77	82	73	0	0				West panel to bottom strut. Color, Black with browni
	" 20		11[15] to 5[0]	Cloudy	95	80	81	73	19.00	4.96				E. panel top work. Sept. 23. opened ½ bbl. f
	" 21		8[30] to 2[30]	Clear	86	52	84	72	15.50	1.68				E. " and outside top chords tion. An easily worked
	" 22		11[15] to 4[0]	Cloudy	93	72	81	70	8.00	1.15				W. panel bottom chord and strut. Dries quickly. Quite fir
	" 23		0	Clear	71		73		0	0				Sunday
	" 24		7[30] to 10[15]	"	73	39	68	60	5.00	0.88				Completed E. bottom chords.
	" 25		0	"	66	47	69	53	0	0				
	" 26		0	Cloudy & Showers	82	69	74	57	0	0				
	Totals								47.50	8.67	10.46	6.62	5740	Foreman's time omitted.
														The weather record is only for 7[30] A.M. to 5 P.M.
3rd Coat														Paint received June /
	Oct. 1		0	Cloudy	83	70	58	52	0	0				
	" 2		9[30] to 4[45]	"	88	71	67	56	27.50	5.53				Both panels to bot. chord. Color, same as 2nd coat
	" 3		12[15] to 7[30]	Fair	78	59	70	61	4.25	1.60				Bottom chords and braces. Oct. 1. opened ½ bbl. foun
	" 4		0	Rain Storm	95	95	66	63	0	0				coat. Same working con
	" 5		12[15] to 1[30]	Fair	95	67	74	64	2.00	0.35				Top chords on outsides. Oct. 4. a heavy paste rise
	" 6		0.	Showers	92	90	68	66	0	0				and thin skin.
	" 7		0	Fair	44		61		0	0				Sunday Oct. 13. shows a heavy bod
	Totals								33.75	7.48	10.46	6.24	4866	Foremans time omitted. out except at top of wes
														little gloss.

SEC. No. 5.

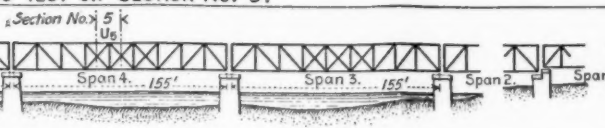
Note: Test Plates in Triplicate.— 3 for each Spreading Rate. { Max. Temp. is for the Paint Room. Min. " " from Daily Outside Record. Humidity " " " " "

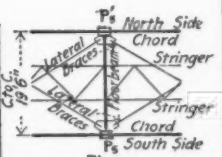
RECORD OF PLATE

	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used a.	Paint Used gal.
			Spreading Rate of 1200 sq. ft. per Gallon.						
FIRST COAT	1	Aug. 16	88°	72.5°	84	72	24 hr.	23.62	1/200
Weight per gal. 10.41 lb.	2	" "	"	"	"	"	"	"	"
Specific Gravity 1.25	3	" "	"	"	"	"	"	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.								
SECOND COAT	1	Sept 20	86°	73°	95	80	24 hr	23.74	1/200
Weight per gal. 10.46 lb.	2	" "	"	"	"	"	"	"	"
Specific Gravity 1.26	3	" "	"	"	"	"	"	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.								
THIRD COAT	1	Oct. 2	72°	56°	88	71	24 hr.	23.73	1/200
Weight per gal. 10.46 lb.	2	" "	"	"	"	"	"	"	"
Specific Gravity 1.26	3	" "	"	"	"	"	"	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.								

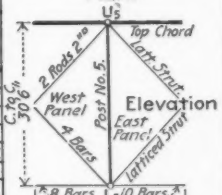
	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min
		Spreading Rat		
	1	Aug 16	88°	72.5
	2	" "	"	"
	3	" "	"	"
	1	Sept 20	86°	73°
	2	" "	"	"
	3	" "	"	"
	1	Oct. 2	72°	56°
	2	" "	"	"
	3	" "	"	"

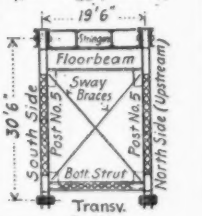
G TEST ON SECTION NO. 5.





Plan.





Transv. Section.

e $1.25 per gal. in bbl. — This barrel of paint was found stiff and easily and kept in good suspension.
nt the workmen would not take the time to brush it out because t set slowly and took about 3 days to dry hard to the thumb

stringer (west half of section) was badly rusted, but well cleaned.
and stringers (east half of section) were badly rusted, but well cleaned.
of section) were badly rusted, but fairly well cleaned.
side surfaces of the top chord, swabs at the ends of all lacing
ars and diagonal bars. All other parts were painted with standard round

ed June /06 in ½ barrels.
with brownish tint Price ----- per gallon.
pened ½ bbl. found no considerable separa-
easily worked paint.
y. Quite firm after 24 hours.

This coat applied (same as 1st. coat) to all available surfaces except the top side of floor system which was painted Red Lead before the track was laid. Brushes used were same kind as on 1st. coat.

Note: A shop coat of Red Lead was put on inside of top chords and on post pins and floorbeam flange angles.

A.M. to 5 P.M.
ed June /06 in ½ barrels.
as 2nd coat Price ------ per gallon.
ed ½ bbl. found same conditions as in 2nd.
e working conditions as 2nd coat.
avy paste rises to surface of bbl. over night
kin.
ws a heavy body of paint fairly well brushed
at top of west panel on north side. Very

This coat applied to same surfaces as 2nd coat except omitted from inside of top chords and no long handle brushes used.

Surfaces not accessible for using wire brushes in cleaning are to be omitted from test comparisons.

OF PLATE TESTS.

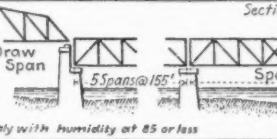
Nov. 1 to 3, 06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

Spreading Rate of 900 sq. ft. per Gallon.								Spreading Rate of 600 sq. ft. per Gallon.							
	Temp., Fahr.		Humidity		Time req'd	Paint Used			Temp., Fahr.		Humidity		Time req'd	Paint Used	
	Max.	Min.	Max	Min.	to Dry	q.	gal.	Plate No.	Date 1906	Max.	Min.	Max.	Min.	to Dry	q.	gal.
16	88°	72.5°	84	72	24 hr.	3149	1/50	1	Aug. 16	88°	72.5°	84	72	24 hr.	4124	1/50
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"
20	86°	73°	95	80	24 hr.	3165	1/50	1	Sept 20	86°	73°	95	80	24 hr.	4148	1/50
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"
2	72°	56°	88	71	24 hr.	3164	1/50	1	Oct. 2	72°	56°	88	71	24 hr	4146	1/50
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST ON

Sect

HAVRE DE GRACE



Paint was applied only with humidity at 85 or less

	'06 Date	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
1st Coat	Aug. 20		9[15] to 1[20]	Clear	85	76	83	78.5		gal.	lb.	sq ft	sq ft	Remarks :– Color, bright red. Price per gal.
	" 21		11[20] to 5[10]	Fair	84	81	82	80						good suspension and to have no settlement
	" 22		9[15] to 2[45]	Clear	78	76	82	76.5						working, and hard to fill cracks about rivet
	" 23		9[25] to 4[45]	"	85	76	83	78.5						The bottom of both chords and stringers (w
	" 24		12[25] to 2[55]	Cloudy	84	72	68							cleaned. The upper lateral braces (west half of
	" 25		2[25] to 4[45]	"	85	69	80	69						south outside surface of post P_2 was badly r
	" 28		9[20] to 2[45]	"	80	71	69	56.5						south sides of bridge (west half of section) w
	" 29		1[25] to 2[55]	Clear	82	73	73							Manhelpers were used inside of top chord.
	" 30		1[25] to 5[15]	Fair	85	80	78	79.5						between bottom chord bars and diagonal bars.
	" 31		8[50] to 3[15]	Clear	74	50	79	74						This paint was a ready mixed red lead with
	Sept. 1	(2d 30							14.50	4.6	12.01	393.5	5140	
2nd Coat	Sept. 19		0	Fair	95	77	82	73	0	0				Paint received June 1906
	" 20		12[20] to 5[55]	Cloudy Showers	95	80	81	78	9.	2.85				Color Red Price per gal
	" 21		8[30] to 5[45]	Clear	86	52	84	75	25.50	3.69				Sept. 19th opened ½ bbl. A h
	" 22		0	Cloudy Showers	93	72	81	70	0	0				separation. Is stiff under th
	" 23		0	Clear	71		73		0	0				much brushing out to get
	" 24		7[35] to 4[35]	"	73	39	66	60	25.00	2.29				
	" 25		7[35] to 8[00]	"	66	47	69	53	1.00	0.25				Dries slowly but is quite t
	" 26		0	Cloudy Showers	82	69	74	57	0					
	Totals								60.50	9.08	12.79	463.2	5140	
3rd Coat	Oct. 1	0	0	Cloudy Showers	83	70	58	52	0					Paint received in ½ bbl.
	" 2		9[15] to 4[00]	Cloudy	88	71	67	56	6.50	2.51				Color Black. Price per
	" 3		7[30] to 5[00]	Fair	78	59	70	61	10.75	2.23				Oct. 1st opened ½ bbl. A lig
	" 4		0	Rain Storm	95	95	66	63	0	0				tion. A thin skin forms on
	" 5		12[30] to 3[00]	Fair Mostly Clear	95	67	74	64	2.00	0.33				
	" 6		0	Showers	92	90	68	66	0	0				Oct. 13 this section shows a
	" 7		0	Fair Mostly Clear	44		61		0	0				coat except ends of lattice ba
	Totals								29.25	5.06	8.69	972	4920	
														much 2nd coat applied not
														Oct. 6th made water marks

Sec. 6. Foreman's time omitted

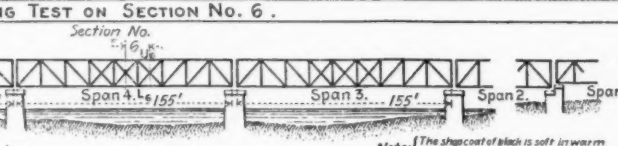
Note: The weather record is 7[30] A.M. to 5 P.M only

Note: Test Plates in Triplicate. 3 for each Spreading Rate. Max. Temp. is for the Paint Room. Min. " " from Daily Outside Record. Humidity " " " " "

RECORD OF PLATE

	Plate No.	Date 1906	Spreading Rate of 1200 sq ft per Gallon. Temp. Fahr. Max.	Min.	Humidity Max.	Min.	Time reqd to Dry	Paint Used gal.		Plate No.	Date 1906	Spreading Ra Temp. Fah Max.	Min.
First Coat	1	Aug. 21	88°	80°	84	81	24 hours	3859	1/200	1	Aug. 21	88°	80
Weight per gal. 17.01 lb.	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 2.04	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.												
Second Coat	1	Sept. 22	78°	70°	93	72	24 hours	3244	1/200	1	Sept. 22	78°	70
Weight per gal. 14.29 lb	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.72	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.												
Third Coat	1	Oct. 3	62°	61°	78	59	24 hours	19.64	1/200	1	Oct. 3	62°	61
Weight per gal. 8.656 lb	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.04	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.												

...G TEST ON SECTION No. 6.

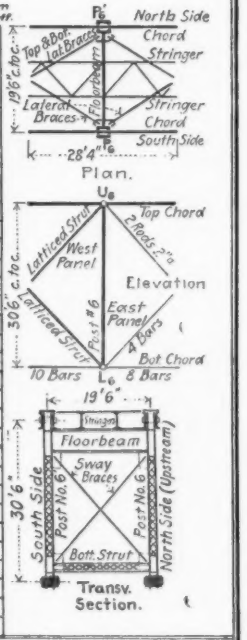


...less

Note: The shop coat of black is soft in warm weather but cannot be scraped off.

...rice per gal. in bbl. This paint on opening barrel was found in ... settlement at the bottom. It was too thick and heavy for easy ... about rivet heads. It set slowly and took about 4 days to dry hard. ... stringers (west half of section) were badly rusted, but fairly well ...vest half of section) were badly rusted but fairly well cleaned. The ... was badly rusted, but well cleaned. The 2"ø diagonal bars both north and ... of section) were badly rusted, but fairly well cleaned. ...top chord. Swabs were used at the ends of all lacing bars and ...agonal bars. All other parts were painted with standard round poond brushes. ...red lead without any tint.

...d June 1906 in ½ bbl.	2nd coat applied to same surfaces
Price per gal.	as 1st coat. No paint applied to top
...d ½ bbl. A heavy mixture but no	side of floor system as that was paint-
...tiff under the brush and requires	ed Red lead before the track was
...g out to get an even coat.	laid.
	Brushes used were same kind as
...but is quite firm in 72 hours.	1st coat.
	Surfaces not accessible for
...er record is from	wire brush cleaning are not
...6 P.M only	to be considered as a part of
	the test.
...ed in ½ bbl. in June 1906	3rd coat applied to same surfaces
Price per gallon.	as 2nd coat except omitted from
...½ bbl. A light body with no separa-	inside of top chords as they had a
...in forms on surface in bbl. in 24 hr.	good Red lead coat before e-
	rection.
...ion shows a good gloss and firm even	No long handle (manhelper)
...s of lattice bars not well brushed on the	brushes were used.
...t side, and on west face of floor beam too	A shop coat of Red lead was put under
...t applied not well brushed. Showers of	flange and stiffener angles of stringers
...ater marks in color on south outside.	& floor beams, and in post pin connec's.



...OF PLATE TESTS.

Nov. 1 to 3, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

...te	Temp., Fahr.		Humidity		Time req'd	Paint Used	
...6	Max.	Min.	Max.	Min.	to Dry	q.	gal.
...21	88°	80°	84	81	24 hours	51.45	1/150
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...

Spreading Rate of 900 sq. ft. per Gallon.

...t.22	78°	70°	93	72	24 hours	43.25	1/150
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...

...3	62°	61°	78	59	24 hours	26.18	1/150
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...

Spreading Rate of 600 sq. ft. per Gallon.

Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
1	Aug. 21	88°	80	84	81	24 hours	77.18	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Sept. 22	78°	70°	93	72	24 hours	64.88	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Oct. 3	62°	61°	78	59	24 hours	39.28	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

Record of Painting Test o

Sec

Paint was applied when humidity was 85 or less

	Date 1906	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	Remarks
										gal.	lb.	sq ft	sq ft	
1st Coat	Aug. 28		9[30] to 12[30]	Cloudy	80	77	70	66						Remarks:– Color bluish lead.– Price $
	29		1[30] to 2[30]	Clear	8	2	7	3						tin cans, which on opening was found
	30		12[30] to 5[30]	Fair	85	80	80	79						2 inches of soft stuff in bottom. It was
	31		8[30] to 5[30]	Clear	74	50	79	74						with it because it worked easily. It al
	Sept. 1		7[30] to 4[30]	"	74	34	72	65	18.00	4.14				The south outside surface of Post P
	4		8[30] to 12[30]	"	55	48	72	58	7.00	1.71				this post were badly rusted but well
	Totals	142.00							64.00	16.6	1220	306	5080	(west half of section) were badly rusted
														of both north and south sides of brid
														fairly well cleaned.
														Manhelpers were used on the inside surf
														between bottom chord and diagonal bars. All
2nd Coat	Sept. 20		0	Cloudy	95	80	81	73	0	0				Weather record is for 7[30] A.M. to 5 P.M. only. Paint received in A
	21		8[30] to 12[30]	Clear	86	52	84	72	11.00	2.20				West panel top & floorbeam. Color Bluish lead
	22		0	Cloudy	93	72	81	70	0	0				Waiting for paint to arrive. Same conditions a
	23		Sunday	Clear	71		73		0	0				Sunday. the same mixture.
	24		7[30] to 5[30]	"	73	39	68	60	19.00	3.56				Both panels to bot. chord & top outsides. brush. Works out to
	25		8[30] to 12[30]	"	66	47	69	53	8.50	1.73				" " bottom chord & braces. in the can and a v
	26		0	Cloudy	82	69	74	57	0	0				night. Sets quite
	Totals								38.50	7.55	1145	666	5031	Foreman's time omitted.
3rd Coat		3rd. coat on down stream half only												Paint received Oct.
	Oct. 1		0	Cloudy	83	70	58	52	0	0				Color same as 1st.
	2		4[30] to 5[30]	"	88	71	67	56	2.50	0.40				West panel top & floorbeam Oct. 2nd opened 10
	3		7[30] to 2[30]	Fair	78	59	70	61	10.75	1.30				Both panels down to bot. chord ditions normal and
	4		0	Rain Storm	95	95	66	63	0	0				This coat sets in 2
	5		12[30] to 2[30]	Fair	95	67	74	64	4.50	0.71				Bottom chords & top outsides
	6		0	Showers	92	90	68	66	0	0				
	7		Sunday	Fair	44		61		0	0				Note The shop
	Totals								17.75	2.41	1178	873	2106	Foreman's time omitted. stringers
														warm w

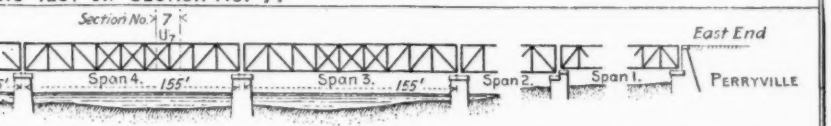
Sec. No. 7.

Note: Test Plates in Triplicate. 3 for each Spreading Plate.
Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record
Humidity " " " " "

Record of Plate

	Spreading Rate of 1200 sq ft per Gallon.									Spreading Ra			
	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time read to Dry	Paint Used g.	Paint Used gal.	Plate No.	Date 1906	Temp., Fah Max.	Temp., Fah Min.
First Coat	1	Sept. 4	74°	58°	55	48	24 hr.	27.73	1/60	1	Sept. 4	74°	58
Weight per gal. 12.226 lb.	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.47	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.												
Second Coat	1	Sept. 24	64°	60°	73	39	24 hr.	25.99	1/100	1	Sept. 24	64°	60
Weight per gal. 11.461 lb.	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.38	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.												
Third Coat	1	Oct. 3	62°	61°	78	59	24 hr.	26.73	1/100	1	Oct. 3	62°	61
Weight per gal. 11.783 lb.	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.41	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.												

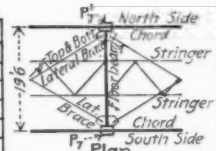
NG TEST ON SECTION No. 7.

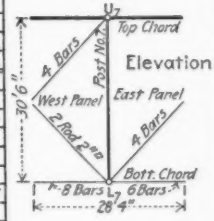


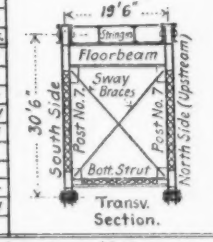
d.–Price $1.50 per gal. in bbl.–This paint was received in 10 gal.
was found in good condition except a settlement of about
om. It was easily stirred and the painters were pleased
sily. It also was slow setting.
e of Post P_7' and also the east and west outside surfaces of
d but well cleaned. The bottom of upper lateral braces
dly rusted but fairly well cleaned. The 2"" diagonal bars
des of bridge (east half of section) were badly rusted but

inside surfaces of the top chord, swabs at the ends of lattice bars,
al bars. All other parts were painted with standard round pound brushes.

received in Aug. & Sept. '06 in 10 gal. tin cans	This coat applied on same
Bluish lead Price ----- per gal.	surfaces as 1st coat.
conditions as 1st coat and apparently	No paint applied on the top side
me mixture. Medium stiff under the	of floor system as that was
Works out to an even coat. Settles a little	painted Red lead before the
can and a very thin skin forms over	track was laid.
Sets quite firm in 30 hr.	Brushes used were same kind
	as used on first coat.
	Surfaces not accessible for using
	wire brushes are not to be con-
	sidered in the test comparisons.
received Oct. 1st. in 10 gal. tin can.	This coat applied on down stream
same as 1st. & 2nd coats. Price per gal.	half only and was omitted from
nd opened 10 gal. can rec'd yesterday, con-	the inside of the top chord box
s normal and same as 2nd coat.	(lattice) girder as that rec'd Red
at sets in 24 hr.; is but little wet 10 hr. on.	lead before erection. Red lead
	was also used in making the
	post pin connections, also
ote The shop coat of black on floorbeam	under the flange and stiffen-
stringers and truss bars is soft in	er angles on the stringers and
warm weather but cannot be scraped off.	floorbeams.







O OF PLATE TESTS.

Nov. 1 to 3, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x $\frac{1}{2}$" ± (No. 10 Gage), Weight 35 lb. ±

Spreading Rate of 900° per Gallon.								Spreading Rate of 600° per Gallon.							
te 06	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max	Humidity Min	Time req'd to Dry	Paint Used g.	Paint Used gal.	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used g.	Paint Used gal.
4	74°	58°	55	48	24 hr.	36.98	1/60	1	Sept. 4	74°	58°	55	48	24 hr.	55.46	1/60
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"
24	64°	60°	73	39	24 hr.	34.66	1/60	1	Sept. 24	64°	60°	73	39	24 hr.	51.98	1/60
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"
3	62°	61°	78	59	24 hr.	35.64	1/60	1	Oct. 3	62°	61°	78	59	24 hr.	53.46	1/60
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST

HAVRE DE GRACE — Draw Span — 55 spans @ 155'

Paint was applied when humidity was 85 or less

	Date 1906	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used gal.	Weight of Paint per Gal. lb.	Area Covered per Gal. sq. ft.	Total Area Covered sq. ft.	Remarks
1st Coat	Aug. 28		9[30] to 12[30]	Cloudy	80	77	70	66						Remarks:– Color bluish lead.–Price $
	29		1[30] to 2[30]	Clear	82		73							tin cans, which on opening was found
	30		1[30] to 5[30]	Fair	85	80	80	79						2 inches of soft stuff in bottom. It wa
	31		8[30] to 5[30]	Clear	74	50	79	74						with it because it worked easily. It a
	Sept. 1		7[30] to 4[30]	"	74	34	72	65	18.00	4.14				The south outside surface of Post
	4		8[30] to 12[30]	"	55	48	72	58	7.00	1.71				this post were badly rusted but well
	Totals	142.00							64.00	16.6	122	306	5080	(west half of section) were badly ruste
														of both north and south sides of bri
														fairly well cleaned.
														Manhelpers were used on the inside surf
														between bottom chord and diagonal bars. All
2nd Coat	Sept. 20		0	Cloudy	95	80	81	73	0	0				Weather record is for 7[30] A.M. to 5 P.M. only. Paint received in
	21		8[30] to 1[30]	Clear	86	52	84	72	11.00	2.20				West panel top & floorbeam. Color Bluish lead
	22		0	Cloudy	93	72	81	70	0	0				Waiting for paint to arrive. Same conditions
	23		Sunday	Clear	71		73		0	0				Sunday. the same mixture
	24		7[30] to 5[30]	"	73	39	68	60	19.00	3.56				Both panels to bot. chord & top outsides. brush. Works out t
	25		8[30] to 12[30]	"	66	47	69	53	8.50	1.79				" " bottom chord & braces. in the can and a
	26		0	Cloudy	82	69	74	57	0	0				night. Sets quite
	Totals								38.50	7.55	145	606	5031	Foreman's time omitted.
3rd Coat		3rd coat on down stream half only												Paint received Oc
	Oct. 1		0	Cloudy	83	70	58	52	0	0				Color same as 1st.
	2		8[30] to 5[30]	"	88	71	67	56	2.50	0.40				West panel top & floorbeam Oct. 2nd opened 10
	3		7[30] to 2[30]	Fair	78	59	70	61	10.75	1.30				Both panels down to bot. chord ditions normal an
	4		0	Rain Storm	95	95	66	63	0	0				This coat sets in
	5		12[30] to 2[30]	Fair	95	67	74	64	4.50	0.71				Bottom chords & top outsides
	6		0	Showers	92	90	68	66	0	0				
	7		Sunday	Fair	44		61		0	0				Note The sho
	Totals								17.75	2.41	1.78	873	2106	Foreman's time omitted. stringer
														warm

SEC. No. 7.

Note: Test Plates in Triplicate. 3 for each Spreading Rate.
Max. Temp. is for the Paint Room. Min. " " from Daily Outside Record. Humidity " " " " "

RECORD OF PLATE

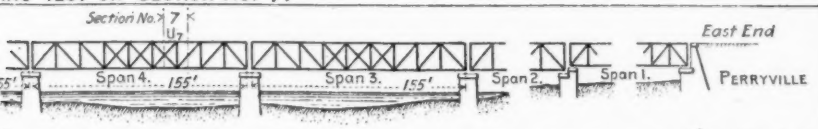
Spreading Rate of 1200 sq. ft. per Gallon.

	Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used qt.	Paint Used gal.
First Coat	1	Sept. 4	74°	58°	55	48	24 hr.	27.73	1/200
Weight per gal. 12.226 lb.	2	" "	"	"	"	"	" "	"	"
Specific Gravity 1.47	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.								
Second Coat	1	Sept. 24	64°	60°	73	39	24 hr.	25.99	1/200
Weight per gal. 11.461 lb.	2	" "	"	"	"	"	" "	"	"
Specific Gravity 1.38	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.								
Third Coat	1	Oct. 3	62°	61°	78	59	24 hr.	26.73	1/200
Weight per gal. 11.783 lb.	2	" "	"	"	"	"	" "	"	"
Specific Gravity 1.41	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.								

Spreading R

Plate No.	Date 1906	Temp. Fa Max.	M
1	Sept. 4	74°	5
2	" "	"	
3	" "	"	
1	Sept. 24	64°	6
2	" "	"	
3	" "	"	
1	Oct. 3	62°	6
2	" "	"	
3	" "	"	

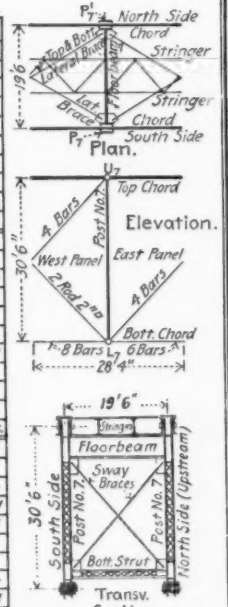
ING TEST ON SECTION No. 7.



ad.–Price $1.50 per gal. in bbl.–This paint was received in 10 gal.
was found in good condition except a settlement of about
tom. It was easily stirred and the painters were pleased
asily. It also was slow setting.
ce of Post P'7 and also the east and west outside surfaces of
d but well cleaned. The bottom of upper lateral braces
adly rusted but fairly well cleaned. The 2" diagonal bars
des of bridge (east half of section) were badly rusted but

e inside surfaces of the top chord, swabs at the ends of lattice bars,
nal bars. All other parts were painted with standard round pound brushes.

t received in Aug. & Sept. '06 in 10 gal. tin cans	This coat applied on same
Bluish lead Price ----- per gal.	surfaces as 1st coat.
e conditions as 1st coat and apparently	No paint applied on the top side
ame mixture. Medium stiff under the	of floor system as that was
. Works out to an even coat. Settles a little	painted Red lead before the
e can and a very thin skin forms over	track was laid.
t. Sets quite firm in 30 hr.	Brushes used were same kind
	as used on first coat.
	Surfaces not accessible for using
	wire brushes are not to be con-
	sidered in the test comparisons.
t received Oct. 1st. in 10 gal. tin can.	This coat applied on down stream
same as 1st. & 2nd coats. Price per gal.	half only and was omitted from
nd opened 10 gal. can rec'd yesterday, con-	the inside of the top chord bar
ns normal and same as 2nd coat.	(latticed) girder as that rec'd Red
oat sets in 24 hr.; is but little wet 10 hr. on.	lead before erection. Red lead
	was also used in making the
	post pin connections, also
Note The shop coat of black on floorbeam	under the flange and stiffen-
stringers and truss bars is soft in	er angles on the stringers and
warm weather but cannot be scraped off.	floorbeams.



D OF PLATE TESTS.

Nov. 1 to 3, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x 5/8" (No. 10 Gage); Weight 35 lb.

Spreading Rate of 900 sq. ft. per Gallon.								Spreading Rate of 600 sq. ft. per Gallon.								
ate 06	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max	Humidity Min	Time req'd to Dry	Paint Used q.	Paint Used gal.	Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
t. 4	74°	58°	55	48	24 hr.	36.98	1/100	1	Sept. 4	74°	58°	55	48	24 hr.	55.46	1/100
"	"	"	"	"	"	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	"	"	"	3	" "	"	"	"	"	" "	"	"
t. 24	64°	60°	73	39	24 hr.	34.66	1/100	1	Sept. 24	64°	60°	73	39	24 hr.	51.98	1/100
"	"	"	"	"	"	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	"	"	"	3	" "	"	"	"	"	" "	"	"
t. 3	62°	61°	78	59	24 hr.	35.64	1/100	1	Oct. 3	62°	61°	78	59	24 hr.	53.46	1/100
"	"	"	"	"	"	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	"	"	"	3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST O

HAVRE DE GRACE — Draw Span — 55 spans @ 155' — 5

Paint was applied only when humidity was 85 or less.

	Date 1906	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used (gal. / lbs.)	Weight of Paint per Gal. (lb.)	Area Covered per Gal. (sq. ft.)	Total Area Covered (sq. ft.)	
1st Coat	Aug. 31	87.30	12^{30} to 5^{00}	Clear	57	50	79		9.20					Remarks:- Color, black. – Price 1^{25} per
	Sept. 1	0	7^{30} to 4^{00}	"	74	34	72	65	10.00	2.49				found thin on top and heavy at bottom wi
	" 2	0	Sunday	Fair	0	omitted			0	0				stirred up easily. The painters on the brid
	" 3	0	Holiday	Cloudy	91	55	82	74	0	0				The bottoms of upper lateral braces (we
	" 4	1.50	7^{30} to 5^{00}	Clear	55	48	72	58	28.00	6.70				cleaned.
	" 5	0	7^{30} to 11^{00}	Fair	72	37	72	58	8.00	0.81				The 1st. coat was applied to all accessible surface
	" 6	0	0	Early fog Clear	99	56	74	57	0	0				of floor system and chords. These were paint
	Totals	88.80							55.20	11.88	9.78	411	4891	track laying. 1st Coat dries in 18 to 20 hr.
									Foremans time omitted					
														Note After 1st. coat the insides of the strin
														effects from grease spatters from p
2nd Coat														Weather record is from — Paint received June /0
	Sept. 20		0	Cloudy	95	80	81	73	0	0				7^{30} A.M. to 5 P.M. only. — Color, a dull black.
	" 21		7^{30} to 5^{30}	Clear	86	52	84	72	5.00	0.94				In top of east panel. — Sept. 20 opened $\frac{1}{2}$ bbl
	" 22		9^{30} to 4^{00}	Cloudy	93	72	81	70	12.00	1.28				East panel to bottom chord — but easily remixed to
	" 23		Sunday	Clear	74		73		0	0				Sunday — Medium light body eas
	" 24		1^{30} to 5^{00}	"	73	39	68	60	10.00	2.44				West panel & bottom strut. — A heavy skin forms in
	" 25		12^{30} to 5^{00}	"	66	47	69	53	6.00	1.40				Bottom work both panels. — Dries in 24 hr. or less
	" 26		10^{30} to 11^{30}	Cloudy	82	69	74	57	2.25	0.34				" " completed top chords outside
	" 27		0	Light Rain	97	79	72	67	0	0				Completed 11^{30} Sept. 26
	Totals								35.25	6.40	9.69	733	4891	Foremans time omitted.
3rd Coat	Oct. 2		0	Cloudy	88	71	67	56	0.50	0				Setting stagings. — Oct. 2. opened $\frac{1}{2}$ bbl
	" 3		7^{30} to 5^{00}	Fair	78	59	70	61	20.50	3.25				Both panels to bottom chord. — a good gloss. Price
	" 4		0	Rainstorm	95	95	66	63	0	0				No work. — Mixture and working c
	" 5		2^{00} to 5^{30}	Fair	95	67	74	64	5.50	0.90				Bottom chord & top outsides — same as second coat.
	" 6		0	Showers	92	90	68	66	0	0				completed 4 P.M. yesterday. — 3rd Coat omitted fro
	7		Sunday	Fair	44		61		0	0				Oct. 13. This section s
	Totals								26.50	4.15	6.39	981	9073	Foremans time omitted — surface except portic
														and the truss diagon
														Not a high gloss.

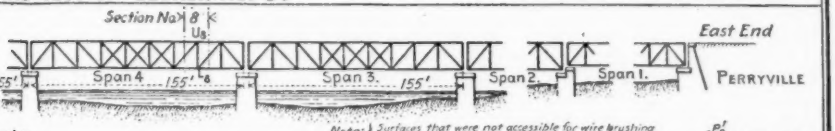
SEC. No. 8.

Note: Test Plates in Triplicate. 3 for each Spreading Rate. { Max. Temp. is for the Paint Room. Min. " " from Daily Outside Record. Humidity " " " " "

RECORD OF PLATE

	Plate No.	Spreading Rate of 1200 sq. ft. per Gallon. Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used gal.	Paint Used fraction	Plate No.	Spreading Ra Date 1906	Temp., Fa Max.	Temp., Fa Min.
First Coat	1	Sept. 4	74°	58°	55	48	24 hr.	22.19	2/100	1	Sept. 4	74	58
Weight per gal. 9.782 lb	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.17	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.												
Second Coat	1	Sept. 22	84°	70°	93	72	24 hr.	21.98	2/100	1	Sept. 22	84°	7
Weight per gal. 9.690 lb	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.16	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.												
Third Coat	1	Oct. 3	62°	61°	78	59	24 hr.	22.19	2/100	1	Oct. 3	62°	6
Weight per gal. 9.759 lb	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.17	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.												

ING TEST ON SECTION No. 8.

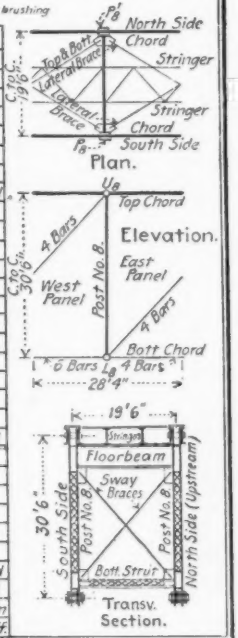


r loss.

Note: { Surfaces that were not accessible for wire brushing are to be omitted from the comparison

rice $1.25 per gal. in bbl. – The barrel of the paint on opening was t bottom with 4 or 5 inches of thick settlement. It mixed and s on the bridge reported that it worked and brushed out freely al braces (west half of section) were badly rusted, but fairly well

essible surfaces except the top side e were painted Red Lead before in 18 to 20 hr.	Sept. 4. bottom chords and bottom lateral braces were scraped with sharp chisel edge scrapers followed by stiff wire brushes (the same as used on other members) by men on a plank hung across below the bottom chords. The paint was applied as follows.
les of the stringers and chords show atters from passing trains.	(a) From a 4 man staging inside the panel suspended from the track timbers 2 men working on sec. 8 and 2 on the adjacent sections (b) Two men on a plank hung across below the bottom chords.
ceived June /06 in ½ barrels. dull black. Price ····· per gallon. opened ½ bbl. found slight settlement ily remixed to an even mixture. light body easily applied. r skin forms in ½ bbl. in 48 hr n 24 hr. or less.	(c) Two men on a plank for the outside of the top chord. Brushes used were one pound round with sheepskin swabs for narrow spaces and long handle double round brushes for inside of top chord. The first coat was started with new brushes.
opened ½ bbl. Color grayish black with gloss. Price per gallon. and working conditions about the s second coat. Dries in 18 hr. at omitted from inside the top chord. This section shows an even smooth e except portions of the north post he truss diagonals in the east panel. high gloss.	A shop coat of Red Lead had been applied inside the top chord and on the pin and nut connections of the posts. Red Lead also shows along the flange and stiffener angles of the floor beams and stringers. The shop coat of black was soft in warm weather but cannot be scraped off.



D OF PLATE TESTS.

Nov. 1 to 3, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

Spreading Rate of 900° per Gallon.

ate 06	Temp. Fahr. Max.	Min.	Humidity Max.	Min.	Time req'd to Dry	Paint Used q.	gal.
pt. 4	74	58	55	48	24 hr.	29.58	1/80
" "	"	"	"	"	" "	"	"
" "	"	"	"	"	" "	"	"
pt. 22	84°	70°	93	72	24 hr.	29.28	1/80
" "	"	"	"	"	" "	"	"
" "	"	"	"	"	" "	"	"
t. 3	62°	61°	78	59	24 hr.	29.52	1/80
" "	"	"	"	"	" "	"	"
" "	"	"	"	"	" "	"	"

Spreading Rate of 600° per Gallon.

Plate No.	Date 1906	Temp. Fahr. Max.	Min.	Humidity Max.	Min.	Time req'd to Dry	Paint Used q.	gal.
1	Sept. 4	74°	58°	55	48	24 hr.	44.38	1/120
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Sept. 22	84°	70°	93	72	24 hr.	43.96	1/120
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Oct. 3	62°	61°	78	59	24 hr.	44.28	1/120
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

Record of Painting Test on

Paint was applied when the Humidity was 85 or less;

Paint rec'd June -----/
Color Dark Brown.

Date '06.	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used gal.	Weight of Paint per Gal. lb.	Area Covered per Gal. sq. ft.	Total Area Covered sq. ft.	Weather record covers only work hr. 7th to 5
First Coat													
Sept. 1	2 1.75	0	Clear	74	34	72	65	0	0				Cleaning Steel
" 2	0	Sunday	Fair	Omitted				0	0				No Work
" 3	0	Holiday	Cloudy	91	55	74	82	0	0				" "
" 4	6.50	7:30 to 5:30	Clear	55	48	72	58	19	5.				West Panel to bottom
" 5	1.50	7:30 to 5:30	Fair	72	37	72	58	27	592				Top outside Exp " and West bottom chords
" 6	0	10:30 to 1:00 PM	Early Fog Clear	99	56	74	57	10.	094				East bottom work
" 7	0	0	Clear	92	57	81	63	0	0				Completed 1 P.M. yesterday
Totals								56.	1186	1043	3904	4628	Foreman's time omitted
Second Coat													
Sept 20		0	Cloudy	95	80	81	73	0	0				
" 21		2:30 to 5:00	Clear	86	52	84	72	5	078				Started 2:30 P.M. top inside west panel
" 22		9:30 to 4:00	Cloudy	93	72	81	70	1/2	192				West panel from floor beam
" 23		Sunday	Clear	71		73		0	0				No Work
" 24		7:30 to 5:00	"	73	39	68	60	17.	238				East panel to bottom chord
" 25		3:30 to 5:00	"	66	41	69	53	4	075				West bottom and strut
" 26		7:30 to 1:00	Cloudy	82	69	74	57	6.25	069				East bottom and top outsides
" 27		0						0	0				Completed 1 P.M. yesterday
Totals								44.25	6.52	968	710	4628	Foreman's time omitted
Third Coat													
Oct. 2		0	Cloudy	88	71	67	56	0	0				Started 10:30 A.M. Oct 3 rd.
" 3		10:30 to 4:30	Fair	78	59	70	61	1950	289				W. panel and inside top of E. pan.
" 4		0	Rain Storm	95	95	66	63	0	0				No Work
" 5		12:30 to 5:30	Fair	95	67	74	64	9	155				E. panel and bottom work
" 6		0	Showers	92	90	68	66	0	0				No Work (about done yesterday)
" 7		Sunday	Fair	44		61		0	0				" "
" 8		8 A.M.	Clear	46	71	60	45	0.50	005				North top outside
" 9		0	Fair	87	69	70	57	0	0				Completed yesterday A.M.
Totals								29.	447	905	890	3980	Foreman's time omitted

Sept. 20th. opened ½ bbl. C
mixture no considerable
siderable skin forms in ½
1st. and 2nd coats dry ver
inside members. Sept. 26th
2nd coat applied to same
and works out easily to an

Oct 2nd opened ½ bbl. Colo
A medium light weight m
Working conditions same
3rd coat not applied on insi
The storm of Oct 4 washed t
batter post and a conside
outside members show a
As the coat was partly d
visable to re-brush it and
judged by members sho

Sec. No. 9.

Note: Test Plates In Triplicate. 3 for each Spreading Rate.
Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record.
Humidity " " " "

Record of Plate

	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used oz.	Paint Used gal.
First Coat Weight per gal. 10.439 lb. Specific Gravity 1.25	Spreading Rate of 1200 sq ft per Gallon.								
	1	Sept. 5	70°	58°	72	37	18 hr.	23.68	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.								
Second Coat Weight per gal. 9.687 lb. Specific Gravity 1.16	1	Sept. 24	68°	60°	73	39	96 hr.	21.97	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.								
Third Coat Weight per gal. 9.019 lb. Specific Gravity 1.09	1	Oct. 3	72°	61°	78	59	216 hr.	20.55	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.								

Spreading Ra

Plate No.	Date 1906	Temp., Fa Max.	M
1	Sept. 5	70°	5
2	" "	"	"
3	" "	"	"
1	Sept. 24	68°	6
2	" "	"	"
3	" "	"	"
1	Oct. 3	72°	6
2	" "	"	"
3	" "	"	"

G TEST ON SECTION NO. 9.

The shop coat of black on the floor-beam and stringers is soft in warm weather but cannot be scraped off.

5 or less, Note: {Surfaces not accessible for wire brushes are omitted from test comparisons.

d June -----/06 in ½ bbl. containers.
Brown. Price per gal.
ed ½ bbl. A pasty separation, but was
Medium weight but requires care-
to get an even coat.
surface in ½ bbl. over night.
ed slight separation behind brushes.
as applied to all accessible surfaces except
floor system and chords, these were
Red Lead before track was laid.
shows on nut and pins of post
nd along the flange and stiffener
e floor beams and stringers

ened ½ bbl. Color Black. An even
considerable separation but a con-
in forms in ½ bbl. over night. Both
coats dry very slowly 36 to 72 hr. on
ers. Sept. 26th drying out O.K.
plied to same surfaces as 1st coat
t easily to an even coat.

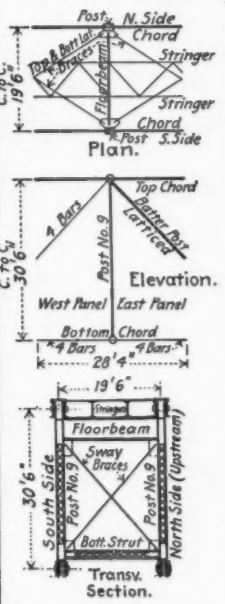
ed ½ bbl. Color Black. Price-----
ght weight mixture easily applied.
ditions same as 1st and 2nd coats.
pplied on inside of top chords.
Oct. 4 washed the South (outside) of the
and a considerable portion of the
bers show a dull surface (no gloss).
was partly dry it did not seem ad-
brush it and the test can only be
nembers showing a gloss.

Condition of Steel.

After using sharp (chisel edge) scrapers followed by stiff steel wire brushes by men on plank between the top chords and stringers and on the regular stagings noted below, there remained about the following percentage of surface covered with the shop coat of black. All horizontal top surfaces 10%, Northpost (sides) 10%, lattice bars 80%, Southpost 80%
Bottom chords 50%. Bottom Strut 40%
Top chords and stringers 80%.
Floor beams 90%. Truss diagonals 90%
Field rivets never painted, All top sides of plates and bracing all rust but smooth.

Paint was applied as follows, (a) from a 4 man staging in the panel, lowered from the track timbers (two men on Sec. 9 and two on the adjacent sections), (b) two men on a plank hung across (below) the bottom chords, (c) two men on a plank for the outsides of the top chords.

Brushes used were lb. round brushes sheep skin swabs in narrow places and long handle double round brushes in the top chords and chairs.
All loose scales and paint was removed.

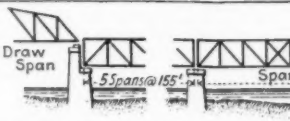


Nov. 13 to 15, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ¼" ± (No. 10 Gage), Weight 35 lb. ±

D OF PLATE TESTS.

Spreading Rate of 900 sq. ft. per Gallon.								Spreading Rate of 600 sq. ft. per Gallon.							
ate 06	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
t. 5	70°	58°	72	37	24 hr.	31.57	1/100	1	Sept. 5	70°	58°	72	37	36 hr.	47.36	1/100
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"
t. 24	68°	60°	73	39	96 hr.	29.29	1/100	1	Sept. 24	68°	60°	73	39	96 hr.	43.94	1/100
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"
t. 3	72°	61°	78	59	216 hr.	27.40	1/100	1	Oct. 3	72°	61°	78	59	216 hr.	41.10	1/100
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST ON



Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
First Coat, applied to all accessible surfaces. Weather record is only for work hr.													Paint was applied only when humidity was 85 or less
Sept. 1	21.75	0	Clear					0	0				Cleaning surface.
" 4	32.00	0	"	55	48	72	64	0	0				" "
" 5	2.00	7:35 to 10:05 AM	Fair	72	37	72	58	19.00	3.40				Painting from inside top & down.
" 6	2.50	10:00 to 12:30 PM	Early Fog Clear	85	56	74	57	17.00	3.98				Lower half of panel and top outsides.
" 7	0	9:00 to 3:30 PM	Clear	85	57	81	67	16.00	3.23				Bottom work and chairs.
" 8	0	0	"	77	41	85	66	0	0				Completed at 3:30 P.M. yesterday.
Totals	58.25							52.00	10.61	2.68	3.79	4028	Foreman's time omitted.
Second Coat, applied to downstream half only.													
Sept. 23		Sunday	Clear	71		73		0	0				No work.
" 24		7:45 to 10:00 AM	"	73	39	68	60	17.00	2.07				All except part of batt.
" 25		0	"	66	47	69	53	0	0				Men working on other Sec.
" 26		8:45 to 3:30 PM	Cloudy	82	69	74	57	12.00	0.66				Completed bottom and top outsides 3.P.M.
" 27		0	Light rain	97	79	72	67	0	0				
" 28		0	Clear	71	54	74	62	0	0				
Totals								29.00	2.73	23%	7.38	2014	Foremans time omitted.
Third Coat, applied to all surfaces except inside the south top chord.													
Oct. 2		0	Cloudy	88	71	67	56	0	0				
" 3		2:00 to 5:00 PM	Fair	78	59	70	61	8.00	1.56				Inside of top and floor beam.
" 4		0	Rain storm	95	95	66	63	0	0				No work.
" 5		12:30 to 5:00 PM	Fair	85	67	74	64	17.25	2.17				Panel ⅓ down.
" 6		0	Showers	92	90	68	66	0	0				No work.
" 7		Sunday	Fair	44		64		0	0				Sunday
" 8		7:45 to 5:00 PM	Clear	71	46	60	45	15.50	1.39				Bottom work and chairs
" 9		0	Fair	87	69	70	57	0	0				south batter post.
" 10		0	"	96	53	53	42	0	0				
" 11		in A.M.	"	82	40	47	38	0.50	0.03				Touching up in chair & post.
" 12		0	Clear	78	50	50	37	0	0				
Totals								41.25	5.15	21.0%	7.27	3744	Foremans time omitted.

Paint rec'd June /06 in
Color, Red. Price
Sept. 5 opened a 10 gal keg. Al
a heavy paste but easily stir
stiff even mixture. Requires
to brush out a good 1st. coat,
is well set. Sept. 7 an even c
applied. Slight separation
track stringers (possibly from

Sept. 21. opened keg of 2nd. c
oil from can rec'd yesterday
per their letter of Sept. 17.
as 1st. coat (a little darker) wor
are same as above.
Sept. 26 A.M. 2 qt. of Sec. 9 blac
spilled on outside of chair an
after sec. 10 paint was part
done except to wipe off the

Oct. 3. took paint from k
and to 124 lb. added oil fro
directed; also added lamp
oil (procured from village sto
dark brown color required b
Working and drying condition
bove. The storm of Oc
sec. 9 black down the south
this sec. As sec. 9 dries slow
delayed.
No paint applied on top side
as it was painted before track lay

A shop coat of Red Lead was used under the flange angl
and Red Lead was used on the post and chair pin con

SEC. No. 10.

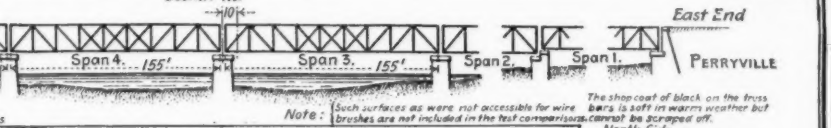
Note: Test Plates in Triplicate. 3 for each Spreading Rate.
Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record.
Humidity " " " "

RECORD OF PLATE

	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used qt.	Paint Used gal.
		Spreading Rate of 1200 sq ft per Gallon.							
First Coat Weight per gal. 26.85 lb Specific Gravity 3.22	1	Sept. 5	76°	58°	72	37	76 hours	60.93	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.								
Second Coat Weight per gal. 23.966 lb Specific Gravity 2.88	1	Sept. 24	68°	60°	73	39	68 hours	54.30	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.								
Third Coat Weight per gal. 21.069 lb Specific Gravity 2.61	1	Oct. 5	76°	64°	95	67	76 hours	49.38	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 900 sq ft per Gallon.								

	Plate No.	Date 1906	Temp., Fah Max.	Temp., Fah Min.
	Spreading Ra			
	1	Sept 5	76°	58
	2	" "	"	"
	3	" "	"	"
	Humidity is days record i			
	1	Sept. 24	68°	60
	2	" "	"	"
	3	" "	"	"
	1	Oct. 5	76°	64
	2	" "	"	"
	3	" "	"	"

G TEST ON SECTION No. 10.



Note: Such surfaces as were not accessible for wire brushes are not included in the test comparisons.

The shop coat of black on the truss bars is soft in warm weather but cannot be scraped off.

ne /06 in 10 gal. kegs
Price ------- per gal.
d a 10 gal. keg. About ½ the bulk
but easily stirred to a quite
ture. Requires good stiff work
good 1st. coat, Sept. 6. 24 hr. on,
ept. 7 an even coat where well
ght separation on inside of
(possibly from engine oil spatter)

d keg of 2nd. coat and added
rec'd yesterday from mfrs. as
r of Sept. 17. Color about same
ttle darker) working conditions
above.
gt. of Sec 9 black paint accidently
ide of chair and post (south post)
aint was partly dry. Nothing
to wipe off the black carefully.

paint from keg of 2nd coat
added oil from mfrs. can as
added lamp black ground in
from village store) to make the
olor required by the Pa. R.R.Co.
drying conditions same as a-
storm of Oct. 4. washed the
down the south batter post on
ec. 9 dries slowly this work was

ied on top side of floor system
d before track laying.
he flange angles of girders

Condition of Steel.

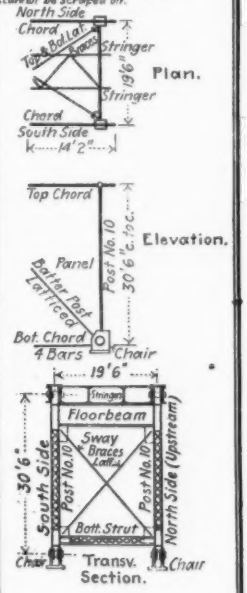
After cleaning all accessible surfaces with sharp chisel edge scrapers followed by stiff steel wire brushes by men on plank between the top chords and stringers, and on the stagings noted below, there remained about the following percent of surface covered with shop coat of black.

Batter posts on inside 90% outsides 50%, floorbeam 90%, stringers and top chords 90%, top bracing 40%, end posts and bracing 80 to 90% south bott. chord outsides 40% inside 60%, north " " " 60% " 60%, bottom bracing and strut and all lattice and connection plates 40% or less. No paint on field rivets, chairs very rusty where not protected with red lead.

Everything loose removed but soft black shop coat on eye bars and floor beam could not be removed by scrapers and seems all right when cold. Soft when warm.

Paint was applied as follows: (a) from a four man staging in each panel (two men on section 10 and two on section 9); (b) two men on a plank hung across (below) the bottom chords; (c) two men on a plank for the outsides of top chords.

Brushes used were round 1 lb. except sheepskin swabs in narrow places and long handle double 1 lb. brushes in the bott. girders and chairs. All brushes were new with the first coat and carefully cleaned each day in changing mixtures.



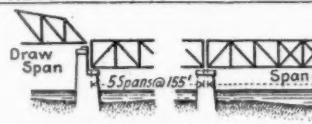
d chair pin connections and shows 5/100 of surface protected before 1st. coat.

Nov. 1 to 3, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36"x 24"x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

O OF PLATE TESTS.

Spreading Rate of 900 sq" per Gallon.									Spreading Rate of 600 sq" per Gallon.									
ate 06	Temp., Fahr. Max.	Min.	Humidity Max.	Min.	Time req'd to Dry	Paint Used q.	gal.		Plate No.	Date 1906	Temp., Fahr. Max.	Min.	Humidity Max.	Min.	Time req'd to Dry	Paint Used q.	gal.	
at 5	76°	58°	72	37	24 hours	81.23	1/150		1	Sept. 5	76°	58°	72	37	24 hours	121.86	1/100	
"	"	"	"	"	" "	"	"		2	" "	"	"	"	"	" "	"	"	
"	"	"	"	"	" "	"	"		3	" "	"	"	"	"	" "	"	"	
s days record in open air. Max. temperature is that of room at application. Min. is open air days record.																		
t. 24	68°	60°	73	39	24 hours	72.48	1/150		1	Sept. 24	68°	60°	73	39	24 hours	108.72	1/100	
"	"	"	"	"	" "	"	"		2	" "	"	"	"	"	" "	"	"	
"	"	"	"	"	" "	"	"		3	" "	"	"	"	"	" "	"	"	
5	76°	64°	95	67	24 hours	65.84	1/150		1	Oct. 5	76°	64°	95	67°	24 hours	98.76	1/100	
"	"	"	"	"	" "	"	"		2	" "	"	"	"	"	" "	"	"	
"	"	"	"	"	" "	"	"		3	" "	"	"	"	"	" "	"	"	

RECORD OF PAINTING TEST ON



Paint was applied only when humidity was 85 or less.

Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered
			First Coat						gal.	lb	sq ft	sq ft
Sept. 4	5.50		0	Fair	72	37	72	58	0	0		
" 5	5.50		0									
" 6	21.50	10^{30} to 5^{00}	Early Fog Clear	Fair	99	56	74	57	3	0.93		
" 7	4.	9^{00} to 5^{00}	Clear		92	57	81	63	18	2.89		
" 8	5.50	9^{00} to 5^{00}	"		72	41	85	66	21	3.29		
" 9	0	Sunday	"		92	77	77	66	0	0		
" 10	0	7^{30} to 10^{30}	"		90	63	84	70	5.50	0.81		
" 11	0	0	"		86	62	84	71	0	0		
Totals	73								47.50	7.92	2.13	509.4028
			Second Coat									
Sept. 23		Sunday	Clear		71		73		0	0		
" 24		4^{30} to 5^{00}	"		73	39	68	60	2.	0.35		
" 25		7^{30} to 3^{00}	"		66	47	69	53	1.9.	2.79		
" 26		7^{00} to 3^{30}	Cloudy		82	69	74	57	9.50	1.86		
" 27		0	Light rain		97	79	67	72	0	0		
" 28		7^{30} to 9^{00}	Fair		71	54	62	74	3	0.29		
" 29		0	Cloudy		87	69	75	64	0	0		
Totals									43.50	4.79	2.67	1.841.4028
			Third Coat									
Oct. 4		0	Rain Storm		95	95	66	63	0	0		
" 5		4^{00} to 5^{00}	Fair		95	67	74	64	2.50	0.46		
" 6		0	Showers		92	90	68	66	0	0		
" 7		Sunday	Fair		44		61		0	0		
" 8		7^{45} to 5^{00}	Clear		46	71	60	45	17.50	2.40		
" 9		10^{00} to 12^{00}	Fair		87	69	70	57	1.75	0.15		
" 10		3^{00} to 5^{00}	"		96	53	53	42	3.50	1.20		
" 11		7^{30} to 12^{00}	"		82	40	47	38	7.50	1.34		
" 12		7^{30} to 9^{00}	Clear		78	50	50	37	3.	0.44		
" 13		0	"		83	34	57	39	0	0		
Totals									35.75	5.99	2.50	5.625.3744

Paint received in June - not mixed until day of ap
. Color Red. price per gal.-
Medium stiff mixture require
ply an even coat. Sept 6th on
ers paint separates as if the
from trains.
Sept. 8th 24 hr. on well set, sho
well brushed.
1st coat on all surfaces except
The shop coat of black is not
but could not be scraped off.
Sept. 24 mixed in store room so
black added to give a light br
ing conditions as 1st coat.

North batter post on outside
This paint requires care in s
out
2nd coat on same surfaces

No paint applied inside the top chord & no marker per brushes used

Third coat same as others
brown (same as sec. 10).
Working conditions same as
Oct. 8th A.M. the surface wa
badly unless extra care was
out. The floor beam and top
a second brushing out to ho
vent creeping. 3rd coat same
in box girders. About 5% of
and girders and chair and po
are covered with Red lead fro
struction.

Foreman's time omitted

SEC. No. 11.

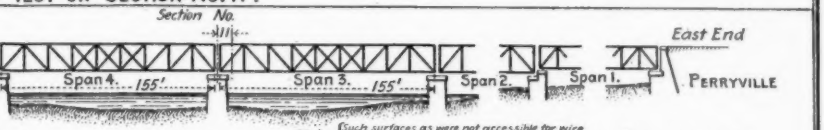
Note: Test Plates in Triplicate. 3 for each Spreading Rate.
Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record.
Humidity " " " " "

RECORD OF PLATE T

	Plate No.	Date 1906	Spreading Rate of 1200 sq ft per Gallon. Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used qt.	Paint Used gal.
First Coat	1	Sept. 7	89°	63°	92	57	24 hours	6	1.95 1/200
Weight per gal. 27.311 lb	2	" "	"	"	"	"	" "	"	" "
Specific Gravity 3.28	3	" "	"	"	"	"	" "	"	" "
	This Paint Spreads Best at 600 sq ft per Gallon.								
Second Coat	1	Sept. 25	67°	53°	66	47	24 hours	6	0.60 1/200
Weight per gal. 26.714 lb	2	" "	"	"	"	"	" "	"	" "
Specific Gravity 3.21	3	" "	"	"	"	"	" "	"	" "
	This Paint Spreads Best at 600 sq ft per Gallon.								
Third Coat	1	Oct. 5	76°	64°	95	67	24 hours	5	6.84 1/200
Weight per gal. 25.051 lb	2	" "	"	"	"	"	" "	"	" "
Specific Gravity 3.13	3	" "	"	"	"	"	" "	"	" "
	This Paint Spreads Best at 900 sq ft per Gallon.								

	Plate No.	Date 1906	Spreading Rate Temp., Fahr. Max.	Temp., Fahr. Min
	1	Sept. 7	89°	63°
	2	" "	"	"
	3	" "	"	"
	The temperatures given			
	1	Sept. 25	67°	53°
	2	" "	"	"
	3	" "	"	"
	Humidity given is day			
	1	Oct. 5	76°	64°
	2	" "	"	"
	3	" "	"	"

TEST ON SECTION No. 11.



Note: Such surfaces as were not accessible for wire brushes are not to be considered in the test.

ived in June ---06 in bbl. and
ntil day of application.
rice per gal.-------
ixture requires careful work to ap-
t. Sept 6th on inside of track string-
ates as if there was oil spatters

n well set, shows an even coat where

rfaces except top side of floor system.
t black is not hard in warm weather
scraped off.
e store room same as 1st coat with
give a light brown color. Same work
s 1st coat.

ost on outside was not evenly applied.
ires care in stirring and brushing

me surfaces as 1st coat.

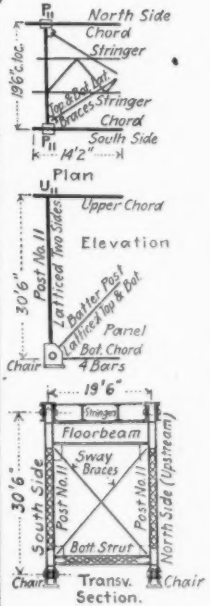
e as others except color dark
s sec. 10).
ions same as 2nd coat except
surface was cold and paint crept
tra care was used in brushing
eam and top members required
ning out to hold the paint and pre-
3rd coat same as 1st except omitted
About 5% of surface on floor beams
chair and post pin connections
h Red lead from shop coat in con-

Condition of Steel.

After cleaning all accessible surfaces with sharp(chisel edge)hand scrapers followed by stiff steel wire brushes, by men on plank between the top chords and stringers and on the stagings noted below, there remained about the following percent of surface covered with the shop coat of black. North chair 5% Red lead 70% black. South chair 5% red 20% black (very rough). Top chords and stringers 70% insides 40% outsides. Bottom chords 20% to 40%. Top bracing 20% to 30%. Bottom bracing 10% End bracing and strut 40%. Posts 70% No paint on field rivets and all surfaces rough. The top side of floor system painted previously Red lead.

Paint was applied as follows (a) from a 4 man staging in each panel (two men on sec. 11 and two on adjacent sections, (b) two men on a plank hung across(below)the bottom chords, (c) two men on a plank for outsides of the top chords.

Brushes were round 1 lb. except sheep skin swabs in narrow spaces, and long handle double round brushes in box girders and chairs. All brushes were new for 1st coat and cleaned for each change.



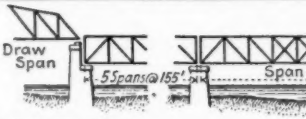
Nov. 1 to 3, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36"x 24"x 5/8"± (No. 10 Gage), Weight 35 lb. ±

OF PLATE TESTS.

Spreading Rate of 900 sq in per Gallon.									Spreading Rate of 600 sq in per Gallon.									
	Temp., Fahr.		Humidity		Time req'd	Paint Used					Temp., Fahr.		Humidity		Time req'd	Paint Used		
	Max.	Min.	Max	Min.	to Dry	q.	gal.	Plate No.	Date 1906	Max.	Min.	Max.	Min.	to Dry	q.	gal.
7	89°	63°	92	57	24 hours	82.60	1/150	1	Sept 7	89°	63°	92	57	24 hours	123.80	1/100
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"
eratures given are, Max. = that of paint room. Min. = lowest record for the day.																		
5	67°	53°	66	47	24 hours	80.80	1/150	1	Sept 25	67°	53°	66	47	24 hours	121.20	1/100
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"
given is days open air record.																		
	76°	64°	95	67	24 hours	15.18	1/150	1	Oct. 5	76°	64°	95	67	24 hours	113.68	1/100
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST ON

HAVRE DE GRACE



Paint was applied with humidity at 85 or less.

Date 1906	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
	First Coat.								gal.	lb.	sq.ft.	sq.ft.	Weather record is of work's hr 7.30 A.M.-5 P.M.
Sept. 5	28.00	0	Fair	72	37	72°	58°	0	0				Started at 7.30 Sept. 6
" 6	28.50	7.30 to 5.00	Early fog Clear	99	56	74	57	3.00	1.01				in top of west panel.
" 7	4.00	9.00 to 5.00	"	92	57	81	63	15.00	4.53				Top & half down W. panel.
" 8	7.00	7.30 to 4.30	"	72	41	85	66	16.00	4.77				E. top and 2/3 down panel.
" 9	0	Sunday	"	97	77	77	66	0					No work.
" 10	9.50	7.30 to 5.00	"	90	63	84	70	19.50	2.60				Bottom work & top outsides.
" 11	0	0	"	86	62	84	71	0	0				Completed yesterday 5 P.M.
Totals	77.00							53.50	12.91	11.89	358	4628	Foremans time omitted.
	Second Coat.												
Sept 24		0	Clear	73	39	68	60	0	0				Started 7.30 Sept. 25.
" 25		7.30 to 4.30	"	66	47	69	53	38.00	5.58				E. panel & 3/4 down W. panel.
" 26		7.30 to 2.45	Cloudy	82	69	74	57	7.50	0.53				W. " " south top outside.
" 27		0	L't rain	97	79	72	67	0	0				No work.
" 28		9.00 to 4.30	Clear	71	54	74	62	7.50	0.67				Bott. chord & N. top outsides.
" 29		0	Cloudy	87	69	75	64	0	0				Completed yesterday 1.30.
Totals								53.00	6.78	8.48	682	4628	Foreman's time omitted.
	Third Coat.												
Oct. 4		0	Rain Storm	95	95	66	63	0	0				
" 5		7.45 to 5.00	Fair	95	67	74	64	2.50	0.29				In top of west panel.
" 6		0	Showers	92	90	68	66	0	0				No work.
" 7		Sunday	Fair	4-4		61		0	0				" "
" 8		7.45 to 5.00	Clear	96	71	60	45	15.50	1.41				West panel and bott. strut.
" 9		7.30 to 4.30	Fair	87	69	70	57	10.50	1.74				East " " top outsides.
" 10		0	"	96	53	53	42	0	0				Men on other work.
" 11		0	"	82	40	47	38	0	0				" " " "
" 12		7.30 to 9.45	Clear	78	50	50	37	2.00	0.41				Completed bottom chord.
" 13		0	"	83	34	57	39	0	0				Sec. " yesterday 9 A.M.
Totals								30.50	3.85	8.49	10 M	3980	Foreman's time omitted.

Remark 3.

Paint rec'd June ---- /06 in
Color, Light Gray. Price ----
Sept. 6, opened 5 gal. can. The
but coarse and heavy for br
quires careful hard brushing t
coat. Sept 10, opened a can
lumps in the bottom. Paint s
and gives a good even coat.
1st. coat was applied to all o
except top side of floor system
ed with Red Lead before track
so shows on nuts and pins of
nections and along edge of fl
er flange angles, and stiffene

Second coat applied to same s
Color, Black rec'd in 5 gal. cans.
Sept. 24 opened 5 gal. can. An
ium thin and easily brushed ou
Sept. 25, the surface was very
to rub out, crept badly and doe
coat. Worked O.K. in warmer

Third coat same as second coat
applied.
Oct. 4, opened 5 gal. can. An e
ture. A slight skin forms on t
in 24 hr

All coats dried quickly (20 hr.)
Oct. 13, shows even coat and go
rough where sheepskin swabs
3rd. coat omitted on inside of

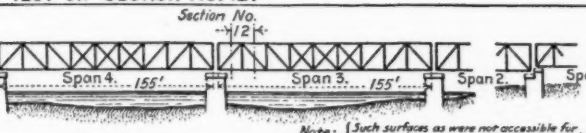
SEC. No. 12.

Note: Test Plates in Triplicate. 3 for each Spreading Rate.
Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record.
Humidity " " " " "

RECORD OF PLATE

	Plate No.	Date 1906	Spreading Rate of 1200 sq ft per Gallon. Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used qts.	Paint Used gal.	Plate No.	Date 1906	Spreading Rat Temp. Fahr Max.	Spreading Rat Min
First Coat Weight per gal. 11.894 lb. Specific Gravity 1.43	1	Sept 7	89°	67°	92	57	24 hr.	26.98	6.75	1	Sept 7	89°	67°
	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.												
Second Coat Weight per gal. 8.485 lb. Specific Gravity 1.02	1	Sept 25	75°	53°	66	47	24 hr.	19.25	4.81	1	Sept 25	75°	53°
	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.												
Third Coat Weight per gal. 8.497 lb. Specific Gravity 1.02	1	Oct 8	50°	45°	71	46	24 hr.	19.28	4.82	1	Oct. 8	50°	45°
	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
	3	This plate discarded.								3	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.												

TEST ON SECTION NO. 12.



The shop coat of black on the truss bars and floor beam is soft in warm weather but cannot be scraped off.

Note: { Such surfaces as were not accessible for wire brushes, are not to be included in the test.

mark3.
ne ---- /06 in 5 gal. cans.
. Price ---- per gal.
gal. can. The mixture is even
heavy for brushing and re-
rd brushing to get an even thin
opened a can and found hard
trom. Paint sets in 20 hours
d even coat.
pplied to all accessible surfaces
f floor system which was coat-
before track laying. Red Lead al-
s and pins of post and chord con-
ng edge of floorbeam and string-
and stiffeners.

ied to same surface as 1st. coat.
l in 5 gal. cans. Price ---- per gal.
5 gal. can. An even mixture med
ily brushed out
face was very cold and color hard
badly and does not cover the 1st.
K. in warmer temperature.

as second coat but more easily

al. can. An even body and mix-
kin forms on this paint in the can

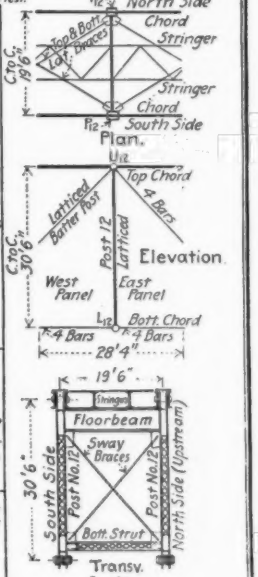
uickly (20 hr.)
en coat and good gloss except
epskin swabs were used.
ed on inside of top chords.

Condition of Steel.

After cleaning all accessible surfaces with sharp (chisel edged) hand scrapers followed by stiff steel wire brushes by men on plank between the top chords and stringers and on the staging as noted below, there remained about the following percentage of surface covered with the shop coat of black:
North post sides 50%; Lattice bars 30%;
South " " 40%; " " 40%
Bottom chords 40%; Bottom strut 30%;
Sway bracing 60%; Top bracing 60%;
Bottom " 10%; No paint on field rivets; Horizontal con. plates 50%; Top chords, stringers and floor beams 80% except bottom sides all rust.

Paint was applied as follows. (a) from a 4 man staging in the panel suspended from the track timbers (2 men on sec. 12 and 2 on the adjacent section) (b) 2 men on a plank hung across (below) the chords. (c) two men on a plank for the outsides of the top chords.

Brushes used were round one pound, with sheepskin swabs for narrow places and long handle round double brushes inside the box girders and chairs. New brushes were used for first coat, and carefully cleaned for each coat.



OF PLATE TESTS.

Nov. 1 to 3, '06, Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

Spreading Rate of 900 per Gallon.

e 6	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
7	89°	67°	92	57	24 hr.	35.97	1/180
"	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"
25	75°	53°	66	47	24 hr.	25.66	1/180
"	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"
9	50°	45°	71	46	24 hr.	25.69	1/180
"	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"

Spreading Rate of 600 per Gallon.

Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
1	Sept. 7	89°	67°	92	57	24 hr.	51.96	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Sept. 25	75°	53°	66	47	24 hr.	38.50	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Oct. 8	50°	45°	71	46	24 hr.	38.50	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST ON S

Paint was applied only with humidity at 85 or less

Date 1906	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
	First	Coat.							gal.	lb.	sq.ft.	sq.ft.	Weather record is for working hours 7 A.M. to 5 P.M.
Sept. 6	34		Early fog Clear	99	56	74	57	0	0				Cleaning the steel
" 7	16		"	92	57	81	63	0	0				" " "
" 8	15	0 to 4	"	72	41	85	66	13	424				Painting W. top outside W. panel ½ down
" 9		Sunday	"	92	77	77	66	0	0				No Work
" 10	5	7 to 5	"	90	63	84	70	5.50	581				W. panel & E. top inside
" 11	2	8 to 12	"	86	62	84	71	4.50	243				Completed section
" 12			"	93	79	81	72	0	0				
Totals	6850							43.	1248	1125	392	4891	Foreman's time omitted
	Second	Coat.											
Sept. 24			Clear	73	39	68	60	0	0				
" 25		7 to 5	"	66	47	69	53	8.50	341				West panel and strut
" 26		7 to 2	Cloudy	82	69	74	57	1.5	248				East panel & south top outs.
" 27		0	Light Rain	97	79	72	67	0	0				No work
" 28		12 to 4	Clear	71	54	74	62	6.50	160				Bot. chords & N. top outside
" 29		0	Cloudy	87	69	75	64	0	0				
Totals								40.	749	1159	653	4891	
	Third	Coat.											
Oct. 8			Clear	71	46	60	45	0	0				
" 9		7 to 4	Fair	87	69	70	57	1.75	415				
" 10		8 to 9	"	96	53	53	42	2.75	023				
" 11		0	"	82	40	47	38	0	0				
" 12		10 to 1	Clear	78	50	50	37	5.50	120				
" 13			"	83	34	57	39	0	0				
Totals								26.	558	1137	730	4073	

Remarks:

Paint received June -----/0
Color, Grayish Black. Pric
Sept. 6, opened 5 gallon kit, a coar
tion that was easily stirred in,
ture that requires much brush
coat. Slight skin in kit in 24 h
firm in 24 hours.
1st coat applied on all accessible
top side of floor system which wa
before track laying. Red lead al
nuts and pins of post connectio
flange and stiffener angles of
and girders. Sept. 24th, a good

2nd coat same color and worki
first coat. Mixture settles badly
Applied to same surface as 1st
Dries quickly. Applied to all s
first coat.
Note:- The shop coat of black o
floor beam is soft in warm
not be scraped off.
3rd coat same mixture and c
and applied to same surfaces
cept inside the top chords.
Dries firm in 24 hours. A thin
kit in 30 hours.
Oct. 13th shows a dark olive bl
coat, except where swabs were
side of west panel not evenly

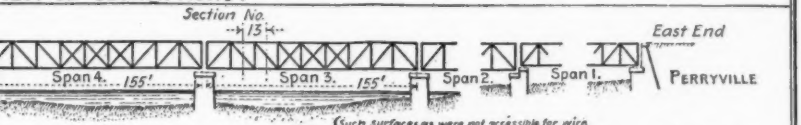
SEC. No. 13.

Note: Test Plates in Triplicate. 3 for each Spreading Rate.
{ Max. Temp. is for the Paint Room. Min. " " from Daily Outside Record. Humidity " " " "

RECORD OF PLATE TE

	Plate No.	Date 1906	Spreading Rate of 1200 sq. ft. per Gallon. Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used qt.	Paint Used gal.	Plate No.	Date 1906	Spreading Rate Temp., Fahr. Max.	Spreading Rate Temp., Fahr. Min.
First Coat	1	Sept. 10	89°	70°	90	63	24 hours	25.53	1/200	1	Sept. 10	89°	70°
Weight per gal. 11.253 lb.	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.35	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.												
Second Coat	1	Sept. 26	76°	57°	82	69	24 hours	25.92	1/200	1	Sept. 26	76°	57°
Weight per gal. 11.392 lb.	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.37	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.												
Third Coat	1	Oct. 8	56°	45°	46	71	24 hours	25.81	1/200	1	Oct. 8	56°	45°
Weight per gal. 11.376 lb.	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 1.37	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq. ft. per Gallon.												

TEST ON SECTION NO. 13.



Note: {Such surfaces as were not accessible for wire brushes are not included in the test comparison..

d June-----/06 in 5 gal. kits.
Black. Price per gal.
llon kit, a coarse stringy separa-
ily stirred in, quite heavy mix-
s much brushing for a good first
n kit in 24 hours. Sets quite

all accessible surfaces except the
stem which was painted Red Lead
g. Red lead also shows on the
post connections and along the
ner angles of the floor beam
t 24th, a good firm coat.

lor and working conditions as
e settles badly in brush pots.
urface as 1st coat.
pplied to all surfaces as with

oat of black on truss bars and
oft in warm weather but can-
off.
ixture and color as 2nd coat
me surfaces as other coats ex-
p chords.
hours. A thin skin forms in the

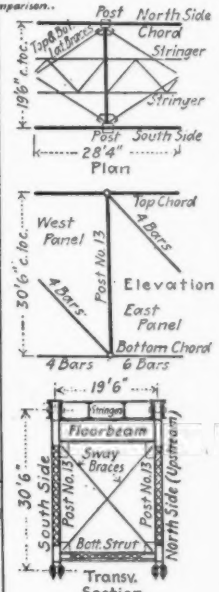
dark olive black and good even
e swabs were used. North out-
l not evenly spread.

Condition of Steel.

After cleaning all accessible surfaces with sharp (chisel edge) scrapers followed by stiff steel wire brushes by men on plank between the top chords and stringers and on the stagings noted below, there remained about the following percent of surface covered with the shop coat of black. Top chord and stringers 80% (rough). North post 80% (inside face very rough). Top bracing 40% connection plates and field rivets no paint. Bottom strut 40% and all horizontal surfaces all rust both sides. Truss diagonals 60% All other members 80% to 90% but rough.

Paint was applied as follows (a) from a 4 man staging in each panel. (2 men on Sec. 13 and 2 on the adjacent sections (b) two men on a plank hung across (below) the bottom chords. (c) two men on a plank for the outsides of the top chords.

Brushes used were one pound round, and sheep skin swabs in narrow places Chairs etc. long handle round double brushes were used in the box girders.
All brushes were new for first coat and cleaned for each coat.



Nov. 1 to 3, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

OF PLATE TESTS.

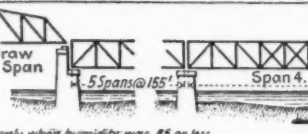
Spreading Rate of 900 sq. ft. per Gallon.

Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
1	Sept. 10	89°	70°	90	63	24 hours	34.04	1/150
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Sept. 26	76°	57°	82	69	24 hours	34.45	1/150
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Oct. 8	56°	45°	46	71	24 hours	34.41	1/150
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

Spreading Rate of 600 sq. ft. per Gallon.

Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
1	Sept. 10	89°	70°	90	63	24 hours	51.06	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Sept. 26	76°	57°	82	69	24 hours	51.84	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"
1	Oct. 8	56°	45°	46	71	24 hours	51.62	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST ON S



Paint was applied only when humidity was 85 or less.

Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
	First Coat								gal	lb.	sq ft	sq ft	
Sept. 6	4	0	Clear	99	56	74	57	0	0				Weather record is for working hours only 7:30 A.M. to 5:30 P.M. Dense fog 7:30 A.M.
" 7	3.2	0	"	92	57	81	67	0	0				Cleaning surface
" 8	1.4	0	"	72	41	85	66	0	0				" "
" 9	0	Sunday	"	92	77	77	66	0	0				Sunday
" 10	5.50	10:30 to 5:30	"	90	63	84	70	12	433				Painting on W. panel from top 1/3 down
" 11	12.75	8:30 to 5:30	"	86	62	84	71	20	587				West panel and in East top
" 12	0	7:30 to 5:30	"	93	79	81	72	13	362				W bot. chord, E. top and top outsides
" 13	0	8:30 to 5:30	Fair	91	76	82	75	14	450	522			East panel and bottom work
" 14	0	0	Cloudy	86	61	73	73	0	0				Completed 5 P.M. Sept. 13th.
Totals	68.25							59.50	1704	2329	295	5031	Foreman's time omitted
	Second Coat							Only Two Coats on Up-Stream Half.					
Sept. 25		0	Clear	66	47	69	53	0	0				
" 26		7:30 to 2:45	Cloudy	82	69	74	57	4.50	165				West panel from top and bot. strut
" 27		0	Showers	97	79	72	67	0	0				
" 28		7:30 to 1:00	Clear	71	54	74	62	13.50	149				West bottom chord, East panel to bottom chord.
" 29		9:00 to 11:15	Cloudy	87	69	75	64	5.	242				East bottom and top outside
" 30		Sunday	Showers last night.	71		67		0	0				Sunday Completed 11:15 29th
Totals								33.	556	8.15	841	2993	Foreman's time omitted
	Third Coat							Three Coats on Down-Stream Half.					
Oct. 8		0	Clear	71	46	60	45	0	0				
" 9		10:00 to 5:00	Fair	87	69	70	57	7.50	272				In top of west panel
" 10		8:30 to 2:00, 2:30 to 4:30	"	96	53	53	42	13.75	204				West panel and in East panel and top outside south chord.
" 11		7:30 to 6:00	"	82	40	41	38	0.50	050				Finished outsides top chord
" 12		8:30 to 4:30	Clear	78	50	50	37	6.25	124				Bottom work
" 13		7:30	"	83	34	57	39	0.25	019				Touched up bottom work Completed 11:30 13th
" 14		Sunday	Fair	76	29	74	48	0	0				Sunday
Totals								28.25	474	8.11	904	4286	Foreman's time omitted

Paint received June ------
Color Red. Price per ga
Sept. 8th opened ½ bbl. A ve
separated and about half p
minutes use of paddle disso
smooth mixture. Very hard
ly. Requires 24 hours to set
hours. Applied to all accessib
the top side of floor system
ed Red lead before track

Sept. 25th opened ½ bbl. Colo
A thin mixture easily app
ful brushing and little paint.
This coat applied to South (dow
also North top west panel dow
and stringers and East up st
Dries slowly 36 hours to set.
Note:- The shop coat of black
bars) is soft in warm weather but

Same mixture as 2nd coat.
Oct. 8th opened ½ bbl. Color and
same as second coat.
This coat applied to all surfac
were given a second coat on up
by mistake and inside of top
has received three coats on
two on the upstream half
Note:- After cleaning ther
pin connections and along
The inside of the top chord

SEC. No. 14.

Note:
Test Plates in Triplicate.
3 for each Spreading Rate.

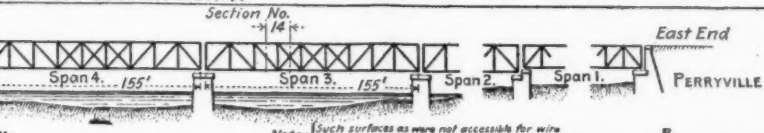
{ Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record
Humidity " " " "

RECORD OF PLATE TE

	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used qt.	Paint Used gal.
	Spreading Rate of 1200 sq ft per Gallon.								
FIRST COAT Weight per gal. 23.298 lb Specific Gravity 1.81	1	Sept. 10	89°	70°	90	63	24 hours	52.85	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon								
SECOND COAT Weight per gal. 8.15 lb. Specific Gravity 0.98	1	Sept. 26	72°	57°	82	69	48 hours	18.49	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.								
THIRD COAT Weight per gal. 8.11 lb Specific Gravity 0.97	1	Oct. 9	64°	57°	87	69	48 hours	18.40	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.								

	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.
	Spreading Rate			
	1	Sept. 10	89°	70°
	2	" "	"	"
	3	" "	"	"
	Humidity is day's record in			
	1	Sept. 26	72°	57°
	2	" "	"	"
	3	" "	"	"
	1	Oct. 9	64°	57°
	2	" "	"	"
	3	" "	"	"

TEST ON SECTION No. 14.



...s.

...ed June ------ 06 in ½ bbl.
Price per gallon.
...½ bbl. A very heavy mixture
about half paste but by a ten
paddle dissolved to an even
re. Very hard to spread proper-
hours to set and is sticky 36
to all accessible surfaces except
floor system which was paint-
efore track laying

...ed ½ bbl. Color Black. Price ---per gal.
...re easily applied but requires care-
...d little paint.
...d to South (down stream) half and
...est panel down to bottom of chord
...nd East up stream track stringer.
...hours to set.
...coat of black (especially on the truss
...arm weather but cannot be scraped off.

2nd coat.
...bbl. Color and working conditions
...coat.
...d to all surfaces except those which
...ond coat on upstream half of section
...inside of top chord. This section
...ree coats on the downstream and
...eam half

...cleaning there remained Red Lead paint on the nuts and pins of the post
...ns and along the flange and stiffener angles of floor beams and stringers.
...f the top chord had also received a coat of Red Lead.

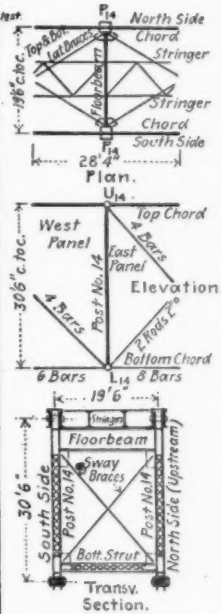
Note: Such surfaces as were not accessible for wire brushes are omitted in comparing for the test.

Condition of Steel.

After using sharp chisel edge hand scrapers, followed by stiff steel wire brushes by men on plank between the top chords and stringers, and on the painters stagings as noted below, there remained the following percent of surface covered with the shop coat of black. Lattice bars 50%. North post (inside) all rust, outside 20%. South post rough outside 80% inside 30%. Batter post rough and very rusty 80%. All horizontal members very rusty 30 to 40%. Field rivets never painted. All other members 60 to 90%. Everything loose was removed by scrapers and brushes.

The painting was as follows. (a) from a four man staging suspended from the track timbers (two men on Sec. 14 & two on the adjacent sections). (b) two men on a plank hung from the bottom chords.

The brushes used were round pound brushes, except sheep skin swabs in the narrow places between bars, and long handle double round brushes inside the box girders and chairs. All brushes were started new (or nearly so) with the first coat and carefully cleaned for each change.



Nov. 1 to 3, 06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x 5/8" ± (No. 10 Gage), Weight 35 lb. ±

F PLATE TESTS.

ading Rate of 900 sq ft per Gallon.								Spreading Rate of 600 sq ft per Gallon.							
Temp. Fahr.		Humidity		Time req'd	Paint Used		Plate	Date	Temp. Fahr.		Humidity		Time req'd	Paint Used	
Max.	Min.	Max.	Min.	to Dry	q.	gal.	No.	1906	Max.	Min.	Max.	Min.	to Dry	q.	gal.
89°	70°	90	63	24 hours	10.46	1/150	1	Sept 10	89°	70°	90	63	24 hours	105.70	1/100
"	"	"	"	" "	" "	" "	2	" "	" "	" "	" "	" "	" "	" "	" "
"	"	"	"	" "	" "	" "	3	" "	" "	" "	" "	" "	" "	" "	" "
ay's record in open air. Temperature Max = paint room at application. Min. is days open air record.															
72°	57°	82	69	48 hours	24.68	1/150	1	Sept 26	72°	57°	82	69	48 hours	36.98	1/100
"	"	"	"	" "	" "	" "	2	" "	" "	" "	" "	" "	" "	" "	" "
"	"	"	"	" "	" "	" "	3	" "	" "	" "	" "	" "	" "	" "	" "
64°	57°	87	69	48 hours	24.53	1/150	1	Oct 9	64°	57°	87	69	48 hours	36.80	1/100
"	"	"	"	" "	" "	" "	2	" "	" "	" "	" "	" "	" "	" "	" "
"	"	"	"	" "	" "	" "	3	" "	" "	" "	" "	" "	" "	" "	" "

RECORD OF PAINTING TEST ON S

Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
									gal	lb.	sq ft	sq ft	
	First Coat												
Sept 6	4	0	Clear	99	56	74	57	0	0				Dense fog 7.30 A.M.
" 7	32	0	"	92	57	81	67	0	0				Cleaning surface
" 8	14	0	"	72	41	85	66	0	0				" "
" 9	0	Sunday	"	92	77	71	66	0	0				Sunday
" 10	5.50	10.30 to 5.00	"	90	63	84	70	12	435				Painting on W. panel from top 1/3 down
" 11	12.75	8.00 to 5.00	"	86	62	84	71	20	587				West panel and in East top
" 12	0	7.30 to 5.00	"	93	79	81	72	13	362				W bot. chord, E top and top outsides
" 13	0	8.30 to 5.00	Fair	91	76	82	75	14.50	522				East panel and bottom work
" 14	0	0	Cloudy	86	61	73	73	0	0				Completed 5 P.M. Sept. 13th.
Totals	68.25							59.50	1704	23.29	295	5031	Foreman's time omitted
	Second Coat							Only Two Coats on Up-Stream Half.					
Sept 25		0	Clear	66	47	69	53	0	0				
" 26		7.30 to 2.45	Cloudy	82	69	74	57	4.50	165				West panel from top and bot strut
" 27		0	Showers	97	79	72	67	0	0				
" 28		7.30 to 1.00	Clear	71	54	74	62	13.50	149				West bottom chord. East panel to bottom chord.
" 29		9.00 to 11.45	Cloudy	87	69	75	64	5.	042				East bottom and top outside
" 30		Sunday	Showers last night.	71		67		0	0				Sunday Completed 11.45 29th
Totals								33.	356	8.15	841	2993	Foreman's time omitted
	Third Coat							Three Coats on Down-Stream Half.					
Oct. 8		0	Clear	71	46	60	45	0	0				
" 9		1.00 to 5.00	Fair	87	69	70	57	7.50	072				In top of west panel
" 10		1.00 to 9.00 2.00 to 4.00	"	96	53	53	42	13.75	204				West panel and in East panel and top outside south chord.
" 11		7.30 to 6.00	"	82	40	47	38	0.50	050				Finished outsides top chord
" 12		7.30 to 4.30	Clear	78	50	50	37	6.25	124				Bottom work
" 13		7.30	"	83	34	57	39	0.25	019				Touched up bot tom work Completed 7.30 13th
" 14		Sunday	Fair	76	29	74	48	0	0				Sunday
Totals								28.25	474	8.11	904	4286	Foreman's time omitted

HAVRE DE GRACE — Draw Span — 5 Spans @ 155' — Span 4.

Paint was applied only when humidity was 85 or less.

Weather record is for working hours only 7.30 A.M. to 5.00 P.M.

Paint received June------
Color Red. Price per ga
Sept. 8th opened ½ bbl. A ve
separated and about half p
minutes use of paddle disso
smooth mixture. Very hard
ly. Requires 24 hours to set
hours. Applied to all accessib
the top side of floor system
ed Red lead before track

Sept. 25th opened ½ bbl. Colo
A thin mixture easily appl
ful brushing and little paint.
This coat applied to South (dow
also North top west panel dow
and stringers and East up st
Dries slowly 36 hours to set.
Note:- The shop coat of black
hours) is soft in warm weather but

Same mixture as 2nd coat.
Oct. 8th opened ½ bbl. Color and
same as second coat.
This coat applied to all surfac
were given a second coat on up
by mistake and inside of top
has received three coats on
two on the upstream half
Note:- After cleaning ther
pin connections and along
The inside of the top chord

SEC. No. 14.

Note: Test Plates in Triplicate. 3 for each Spreading Plate.
Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record
Humidity " " " " "

RECORD OF PLATE TE

FIRST COAT
Weight per gal. 23.298 lb
Specific Gravity 1.81

Spreading Rate of 1200 sq ft per Gallon.

Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time read to Dry	Paint Used qt.	Paint Used gal.
1	Sept. 10	89°	70°	90	63	24 hours	52.85	1/200
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

This Paint Spreads Best at 600 sq ft per Gallon

Spreading Rate

Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.
1	Sept. 10	89°	70°
2	" "	"	"
3	" "	"	"

Humidity is day's record im

SECOND COAT
Weight per gal. 8.15 lb.
Specific Gravity 0.93

Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time read to Dry	Paint Used qt.	Paint Used gal.
1	Sept. 26	72°	57°	82	69	48 hours	18.49	1/200
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

This Paint Spreads Best at 1200 sq ft per Gallon.

Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.
1	Sept. 26	72°	57°
2	" "	"	"
3	" "	"	"

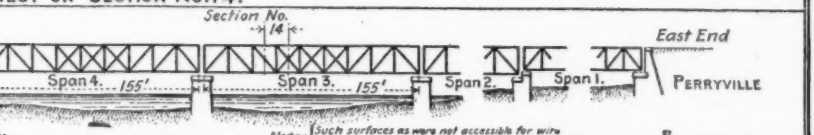
THIRD COAT
Weight per gal. 8.11 lb
Specific Gravity 0.97

Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time read to Dry	Paint Used qt.	Paint Used gal.
1	Oct. 9	64°	57°	87	69	48 hours	18.40	1/200
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

This Paint Spreads Best at 1200 sq ft per Gallon.

Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.
1	Oct. 9	64°	57°
2	" "	"	"
3	" "	"	"

TEST ON SECTION No. 14.



...s.

...ed June ------ 06 in ½ bbl.
Price per gallon.
...½ bbl. A very heavy mixture
about half paste but by a ten
...paddle dissolved to an even
...re. Very hard to spread proper-
...hours to set and is sticky 36
...to all accessible surfaces except
...floor system which was paint-
...efore track laying

...ed ½ bbl. Color Black. Price---per gal.
...ure easily applied but requires care-
...d little paint.
...d to South (down stream) half and
...est panel down to bottom of chord
...nd East up stream track stringer.
...hours to set.
...coat of black (especially on the truss
...arm weather but cannot be scraped off.

2nd coat.
...bbl. Color and working conditions
...coat.
...d to all surfaces except those which
...ond coat on upstream half of section
...inside of top chord. This section
...ree coats on the downstream and
...eam half

...cleaning there remained Red Lead paint on the nuts and pins of the post
...ns and along the flange and stiffener angles of floor beams and stringers.
...f the top chord had also received a coat of Red Lead.

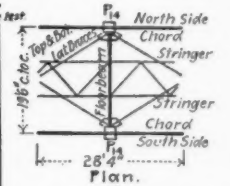
Note: (Such surfaces as were not accessible for wire brushes are omitted in comparing for the test.

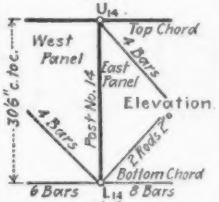
Condition of Steel.

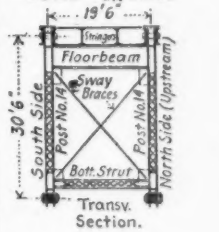
After using sharp chisel edge hand scrapers, followed by stiff steel wire brushes by men on plank between the top chords and stringers, and on the painters stagings as noted below, there remained the following percent of surface covered with the shop coat of black. Lattice bars 50%. North post (inside) all rust, outside 20%. South post rough outside 80% inside 30%. Batter post rough and very rusty 80%. All horizontal members very rusty 30 to 40%. Field rivets never painted. All other members 60 to 90%. Everything loose was removed by scrapers and brushes.

The painting was as follows, (a) from a four man staging suspended from the track timbers (two men on Sec. 14 & two on the adjacent sections). (b) two men on a plank hung from the bottom chords.

The brushes used were round pound brushes, except sheep skin swabs in the narrow places between bars, and long handle double round brushes inside the box girders and chairs. All brushes were started new (or nearly so) with the first coat and carefully cleaned for each change.







Nov. 1 to 3, 06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x 5/8" ± (No. 10 Gage), Weight 35 lb. ±

OF PLATE TESTS.

Spreading Rate of 900 sq. ft. per Gallon.

Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
1	Sept 10	89°	70°	90	63	24 hours	10.46	1/150
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

...y's record in open air. Temperature Max = paint room at application. Min. is days open air record.

1	Sept 26	72°	57°	82	69	48 hours	24.68	1/150
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

Spreading Rate of 600 sq. ft. per Gallon.

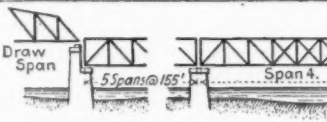
Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
1	Sept 10	89°	70°	90	63	24 hours	108.70	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

1	Sept 26	72°	57°	82	69	48 hours	36.98	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

1	Oct 9	64°	57°	87	63	48 hours	36.80	1/100
2	" "	"	"	"	"	" "	"	"
3	" "	"	"	"	"	" "	"	"

Record of Painting Test on Se

Date 1906	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	Havre de Grace
	hr.								gal.	lb.	sq.ft	sq.ft	Paint was applied only when humidity was 85 or less.
		First Coat											Weather record is for working hours only. 7.30 AM. 5 PM.
Sept. 7	15.50		Clear	92	57	81°	67						Cleaning the steel.
" 8	20.00		"	72	41	85°	66						" " "
" 9	Sunday		"	92	77	77°	66						Sunday
" 10	17.50		"	90	63	84°	70						Cleaning the steel.
" 11	24.25	12[30]to5[00]	"	86	62	84°	71°	9.00	4.69				Painting upper half of W. panel.
" 12	0	1[30]to5[00]	"	93	79	81°	72°	6.50	2.85				W. panel and top of E. panel.
" 13	7.50	8[30]to5[00]	Fair	91	76	82°	75°	20.00	9.54				" " " " " "
" 14		8[00]to3[00]	Cloudy	86	61	73°	73°	16.50	6.32				Bott. chords & top outside E.P.
" 15		0	Cloudy	66	64	68	61°	0	0				Completed 3 P.M. Sept. 14.
Totals	84.75							52.00	23.40	7.27	243	5684	Foremans time omitted.
		Second Coat											
Sept 27			Light Rain	97	79	72°	67°	0					
" 28		7[30]to5[00]	Clear	71	54	74°	68°	19.00	6.20				West panel & E. top inside.
" 29		9[00]to4[00]	Lt showers Cloudy	87	69	75°	64°	16.25	4.97				Completed section.
" 30	Sunday		Clouds	71		67°		0					
Totals								35.25	11.17	7.39	509	5684	Foremans time omitted
		Third Coat											
Oct. 9				87	69	70°	57°						
" 10		10[00]to5[00]	Fair	96	53	53°	41°	21.50	5.94				Both panels to chords.
" 11		8[00]to9[00]	"	82	40	47°	38°	2.00	.040				Top outsides.
" 12		9[00]to5[00]	Clear	78	50	50°	37°	1.25	.054				On bottom chords.
" 13		7[30]till[00]	"	83	34	57°	39°	6.50	1.92				Completed bott. chords.
" 14		0	Fair	76	29	74°	48°	0	0				
								31.25	8.80	7.40	553	4866	Foremans time omitted.



Remarks:

Paint rec'd. June ---/06.
Sept. 10 opened ½ bbl. Color Black
ium thin mixture, no separation.
Very hard to apply brush sticks t
spread thin or even. Dries very
drops are left they were not ha
This coat applied to all surface
floor system This was painted
laying. Red Lead also shows on
and pin connections and on t
ener angles of floor beams and
Sept. 14. wo brush pots sent
from the work with 2 lb. of dr
over. No other separation no
work.

Sept. 27. Rec'd ½ bbl. from mfr. b
" 28. Opened ½ bbl. Same mi
coat Color Black Price ----- p
Same working conditions as 1st
This coat applied to same surfa

Oct. 9. Reopened 2nd. coat ½ bl
it to same surface as 1st. coa
of top chords omitted as they
shop coat of Red Lead.

Note: The shop coat of black
bars is soft in warm w
not be scraped off.

Sec. No. 15.

Note:
Test Plates in Triplicate.
3 for each Spreading Rate.

Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record.
Humidity " " " " "

Record of Plate Te

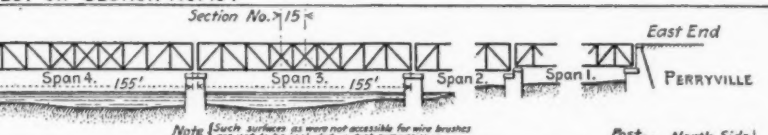
Spreading Rate of 1200 Sq. Ft. per Gallon.

	Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used qt.	Paint Used gal.
First Coat	1	Sept. 12	87°	72°	93	79	12 hr.	26.00	1/200
Weight per gal. 7.271 lb	2	" "	"	"	"	"	" "	"	"
Specific Gravity 0.87	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at (?) per Gallon.								
Second Coat	1	Sept. 28	72°	62°	71	54	12 hr.	22.00	1/200
Weight per gal. 7.346 lb	2	" "	"	"	"	"	" "	23.96	"
Specific Gravity 0.88	3	" "	"	"	"	"	" "	26.86	"
	This Paint Spreads Best at (?) per Gallon.								
Third Coat	1	Oct. 9	64°	57°	87	69	12 hr.	28.95	1/200
Weight per gal. 7.400 lb	2	"	"	"	"	"	" "	33.00	"
Specific Gravity 0.89	3	"	"	"	"	"	" "	35.00	"
	This Paint Spreads Best at (?) per Gallon.								

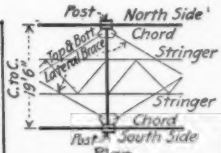
Spreading Rate

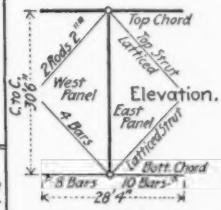
Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.
1	Sept. 12	87°	72°
2	" "	"	"
3	" "	"	"
Sets too quickly to be evenly brus			
1	Sept. 28	72°	62°
2	" "	"	"
3	" "	"	"
Sets too quickly to be evenly brus			
1	Oct. 9	64°	57°
2	" "	"	"
3	" "	"	"
Sets too quickly to be evenly bru			

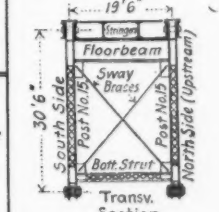
EST ON SECTION No. 15.



Note {Such surfaces as were not accessible for wire brushes are not to be included in test comparisons.







June ---/06. Price ---per gal. bbl. Color Black, an even mediso separation. brush sticks to steel. Cannot en. Dries very quick but where were not hard Oct. 13. to all surfaces except top of was painted red before track also shows on post and nuts ons and on flange and stiffor beams and stringers. sh pots sent to store room th 2 lb. of dry sediment left separation noticed during the	Conditon of Steel. After cleaning all accessible surfaces with sharp (chisel edge) scrapers, followed by stiff steel wire brushes, by men on plank between the top chords and stringers and on the stagings noted below, there remained about the following per cent of surface covered with the shop coat of black: top chords and stringers 80% and rough; post outsides 80%, insides and lattice bars 40%; all horizontal surfaces 10%; bottom struts 70%; truss diagonals 30%, field rivets were never painted.	
l. from mfr. by express. bbl. Same mixture as 1st Price ----- per gal. ditions as 1st. coat. to same surface as 1st. coat.	Paint was applied as follows: (a) from 4 man stagings in the panels; (b) 2 men on sec 15 and 2 men on the adjacent section; (c) 2 men on a plank that is hung across (below) the bottom chords; (d) 2 men on a plank for the outsides of the top stringers.	
nd. coat ½ bbl. and applied e as 1st. coat except inside itted as they had received a Lead. coat of black on the truss ft in warm weather but canraped off.	Brushes used were round, one pound, except sheep skin swabs in narrow spaces, and long handle round double brushes inside the box girders. All brushes were new for the first coat and cleaned for each change.	

Nov. 1 to 3, 06. Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

F PLATE TESTS.

Spreading Rate of 900 sq. in. per Gallon							Spreading Rate of 600 sq. in. per Gallon.								
Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used q.	Paint Used gal.	Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used q.	Paint Used gal.
87°	72°	93	79	12 hr.	26.00	1/100	1	Sept. 12	87°	72°	93	79	12 hr.	31.00	1/100
"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	28.00	"
"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	29.00	"
be evenly brushed out. Could not get the requisite amount on the plates.															
72°	62°	71	54	12 hr.	40.00	1/100	1	Sept. 28	72°	62°	71	54	12 hr.	47.00	1/100
"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	47.00	"
"	"	"	"	" "	43.00	"	3	" "	"	"	"	"	" "	49.00	"
be evenly brushed out.															
64°	57°	87	69	12 hr.	41.45	1/100	1	Oct. 9	64°	57°	87	69	12 hr.	43.00	1/100
"	"	"	"	" "	37.00	"	2	" "	"	"	"	"	" "	47.00	"
"	"	"	"	" "	43.00	"	3	" "	"	"	"	"	" "	53.00	"
be evenly brushed out.															

RECORD OF PAINTING TEST ON S

Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used Gal.	Weight of Paint per Gal. Lb.	Area Covered per Gal. Sq ft	Total Area Covered Sq ft	HAVRE DE GRACE — Draw Span — 5 Spans @ 155' — Span
		First Coat.											Paint applied with humidity at 85 or less. Weather record is for 7.30 A.M. to 5 P.M.
Sept 7	3.00												Cleaning.
" 8	12.50												"
" 9	0	Sunday											Sunday.
" 10	1.45												Cleaning.
" 11	3.05												"
" 12	0	0	Clear	93	79	81	72	0	0				No work.
" 13	0	12h to 5h	Fair	91	76	82	75	9.00	2.97				West panel top inside.
" 14	5.50	8h to 10.5h	Cloudy	86	61	73	73	23.00	4.51				" " down East ½ Do.
" 15	2.00	7h to 12h	Cloudy	66	64	68	61	17.00	3.56				All except East bottom.
" 16	0	Sunday	"	74	65	68	57	0	0				Sunday.
" 17	0	9h to 12h	Fair	84	72	73	61	5.00	1.36				East bottom.
" 18	0	0	"	90	84	77	69	0	0				Completed 12 M. 17th
Totals	7.00							54.00	12.40	9.15	4.58	56.84	Foreman's time omitted.
		Second Coat											
Sept 25		0	Clear	66	47	69	53	0	0				
" 26		2.45 to 5.45	Cloudy	82	69	74	57	4.50	0.60				East panel top inside.
" 27		0	Cloudy (Frain)	97	79	72	67	0	0				No work.
" 28		7h to 12h	Clear	71	54	74	62	14.00	2.95				East panel to bottom. West " top inside.
" 29		9h to 4.5h	Cloudy	87	69	75	64	6.75	1.27				All except East bottom.
" 30		Sunday	Cloudy	71		67		0	0				Sunday.
Oct 1		8h to 10h	Clouds & showers	83	70	58	52	4.00	1.35				East bottom work.
" 2		0	Cloudy	88	71	67	56	0	0				Completed 10 A.M. Oct 1
Totals								29.25	6.15	2.08	9.24	56.84	Foreman's time omitted.
		Third Coat											
Oct 9		Sunday	Fair	87	69	70	57	0	0				Sunday.
" 10		10h to 5h	"	96	53	53	42	14.50	2.25				West panel to bottom. East " top inside.
" 11		7h to 2h	"	82	40	47	38	12.00	1.60				All except Bottom.
" 12			Clear	78	50	50	37	0	0				Waiting for men on bot.
" 13		10h to 2h	"	83	34	57	39	5.25	1.55				All the bottom work.
" 14			Fair	76	29	74	48	0	0				Completed 2.15 P.M. Oct 15
Totals								31.75	5.40	9.24	9.01	48.66	Foreman's time omitted.

Paint received June/06 in ½ bbl. Color, Grayish Black, not a heav separation but easily remix Works free and dries in 24 hr. This coat applied to all acce except the top of floor syste painted Red Lead before tra Lead also shows on nuts and nections and along the flang angles of floorbeams and st

This paint requires frequen

Second coat same as first co to same surfaces. Slow dry 29th. Sticky for 40 hr.

Note The shop coat of black is soft in warm weath scraped off.

Oct. 10th. opened ½ bbl. Same coats. Same working condit paint applied to same surfa coats except omitted ins

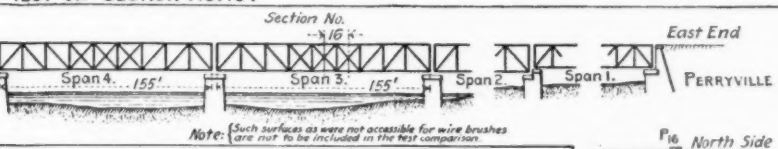
SEC. No. 16.

Note: Test Plates in Triplicate, 3 for each Spreading Rate.
Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record.
Humidity " " " " "

RECORD OF PLATE

	Spreading Rate of 1200 sq ft per Gallon.									Spreading Rat			
	Plate No.	Date 1906	Temp, Fahr. Max.	Temp, Fahr. Min.	Humidity Max.	Humidity Min.	Time reqd to Dry	Paint Used q.	Paint Used Gal.	Plate No.	Date 1906	Temp, Fahr Max.	Temp, Fahr Min
FIRST COAT Weight per gal. 9.154 lb. Specific Gravity 1.10	1	Sept 12.	87	72	93	79	24 hr.	2077	1/200	1	Sept 12	87	72
	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.												
SECOND COAT Weight per gal. 9.219 lb. Specific Gravity 1.11	1	Sept 26	72	57	82	69	24 hr.	2089	1/200	1	Sept 26	72	57
	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.												
THIRD COAT Weight per gal. 9.240 lb. Specific Gravity 1.11	1	Oct. 11	45	38	82	40	24 hr.	2096	1/200	1	Oct. 11	45	38
	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint Spreads Best at 600 sq ft per Gallon.												

TEST ON SECTION No. 16.



Note: {Such surfaces as were not accessible for wire brushes are not to be included in the test comparison.

ne/06 in ½ bbl. Price ---- per gal.
ack, not a heavy mixture slight
easily remixed.
dries in 24 hr. firm in 48 hr.
ed to all accessible surfaces
of floor system which was
ad before track laying. Red
s on nuts and pins of post con-
long the flange and stiffener
beams and stringers.

ires frequent stirring.

---

me as first coat and applied
ces. Slow drying until Sept.
or 40 hr.

coat of black on the truss bars
warm weather but cannot be
off.

---

d ½ bbl. Same mixture as other
orking conditions. Third coat
o same surfaces as other
omitted inside of top chords.

Condition of Steel.

After using sharp (chisel edge) hand scraping chisels followed by stiff steel wire brushes by men on plank between the top chords and stringers and on the regular staging (as noted below) there remained about the following percent of surface covered with the shop coat of black.

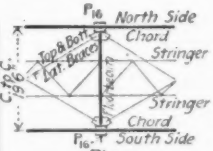
South post (shop coat applied over scales) inside face 40% and rough, South bottom chord (inside rough) 60%, North post outside face 20% and rough. All truss eye bar diagonals 30%. All other surfaces 70 to 90%. Floorbeams 95%. Everything loose was removed.

Paint was applied as follows (a) from 4 man stagings suspended from the track timbers (2 men on sec. 16 and 2 on the adj. sec.) (b) 2 men on a plank across (below) the bottom bracing and chords (c) two men on a plank slung at ends of track timber for outside the top chords.

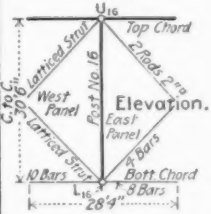
Brushes

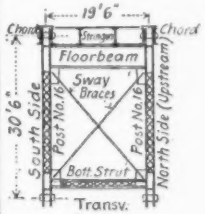
Round pound brushes were used except sheepskin swabs in narrow places between eye bars, and long handle double round brushes in latticed box girders and chairs.

All brushes were new or nearly so and were carefully cleaned at each change.



Plan.





Transv. Section.

OF PLATE TESTS.

Nov. 13 to 15, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 351 lb. ±

Spreading Rate of 900 sq ft per Gallon.									Spreading Rate of 600 sq ft per Gallon.								
e 6	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.		Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
.12	87	72	93	79	24 hr.	27.70	1/80		1	Sept. 12	87	72	93	79	24 hr.	41.54	1/60
"	"	"	"	"	" "	"	"		2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"		3	" "	"	"	"	"	" "	"	"
26	72	57	82	69	24 hr.	27.85	1/80		1	Sept. 26	72	57	82	69	24 hr.	41.78	1/60
"	"	"	"	"	" "	"	"		2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"		3	" "	"	"	"	"	" "	"	"
11	45	38	82	40	24 hr.	27.94	1/80		1	Oct. 11	45	38	82	40	24 hr.	41.92	1/60
"	"	"	"	"	" "	"	"		2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"		3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST ON

Date 1906	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity / Min. "	Max. Temperature / Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
							gall.	lb.	Sq ft	Sq ft	
Sept. 11	1	0	Clear	86 62	84 71	0	0				Weather record is for working hours only. 7:45 A.M. to 5 P.M.
" 12	6.25	0	"	93 79	81 72	0	0				Cleaning Steel
" 13	12	0	Fair	91 76	82 75	0	0				" "
" 14	0.75	2:25 to 5:00	Cloudy	86 61	73 75	6.50	3.10				West panel ½ down
" 15	3.50	12:15 to 5:15	"	66 65	68 65	16.	4.27				West panel to bottom East " top inside
" 16	0	Sunday	"	74 65	68 61	0	0				Sunday
" 17	4.	7:25 to 4:30	Fair	84 72	73 61	14	3.56				East panel & bottom work
" 18	0	0	"	90 84	77 69	0	0				Completed 4 P.M. 17th
Totals	27.50					36.50	10.93	11.92	46.0	50.31	Foreman's time omitted
		Second Coat.									
Sept. 25		0	Clear	66 47	69 53	0	0				
" 26		3:20 to 5:00	Cloudy	82 69	74 57	4.50	0.87				East panel top inside
" 27			Light Showers Cloudy	97 79	72 67	0	0				No work
" 28		7:30 to 4:45	Clear	71 54	74 62	19.	3.56				Both panels to bottom
" 29		11:00 to 4:45	Cloudy	87 69	75 64	8.75	1.37				Bottom work & outside top chord
" 30		Sunday	"	71	67	0	0				Completed 4 P.M. 29th
Totals						32.25	5.80	13.7	86.1	50.31	Foreman's time omitted
		Third Coat									
Oct. 9			Fair	87 69	70 57	0					
" 10		3:25 to 5:25	"	96 53	53 42	4.	0.31				Both panels in top inside
" 11		7:30 to 3:45	"	82 40	47 38	21.	2.99				Both panels to bottom
" 12		8:00 to 5:15	Clear	78 50	50 37	4	0.88				East bottom and Strut
" 13		7:25 to 3:30	"	83 34	57 39	2.25	0.47				West bottom
" 14			"	76 29	74 48	0	0				Completed 3:30 P.M. 13th
Totals						31.25	4.65	3.45	9.10	42.33	Foreman's time omitted

HAVRE DE GRACE — Draw Span — 5 Spans @ 155' — Spa

Paint was applied only when humidity was 85 or less.

Remarks:
Paint received June-----/06 in
Color, Dark Maroon. Price
Sept. 13th opened ½ bbl var
good even mixture, medium
and dries a little slow. Sets
for rain in 20 hours. This c
faces except the top side of
was painted Red lead befo
Red lead also shows on the
post connections, and along
ener angles of the floor be
and on the inside of top ch

Sept. 25th. opened ½ bbl. Sa
ditions as 1st coat.
A considerable skin forms
Oct. 13th shows even coat, go
brush work on inside of No
This coat on same surfaces a

Oct. 10th reopened same ½
all barrels had same mark
Color and working cond
1st coat.
Oct. 13th shows good gloss a
cept on inside of North cho
much paint on 1st coat not w
3rd coat on same surfaces
mitted on inside of top cho

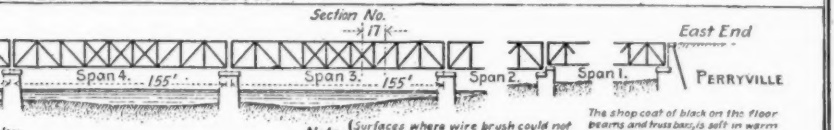
SEC. No. 17.

Note: Test Plates in Triplicate. 3 for each Spreading Rate.
{ Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record.
Humidity " " " " "

RECORD OF PLATE

	Spreading Rate of 1200 sq ft per Gallon.										Spreading Ra									
	Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used qt.	Paint Used gal.		Plate No.	Date 1906	Temp., Fa Max.	Temp., Fa Min.						
FIRST COAT	1	Sept. 14	78°	73°	86	61	24 hours	27.04	1/200		1	Sept. 14	78°	73						
Weight per gal. 11.922 lb.	2	" "	"	"	"	"	" "	"	"		2	" "	"	"						
Specific Gravity 1.44	3	" "	"	"	"	"	" "	"	"		3	" "	"	"						
	This Paint Spreads Best at 1200 sq ft per Gallon.																			
SECOND COAT	1	Sept. 26	72°	57°	82	69	48 hours	30.11	1/200		1	Sept. 26	72°	5						
Weight per gal. 13.273 lb.	2	" "	"	"	"	"	" "	"	"		2	" "	"	"						
Specific Gravity 1.59	3	" "	"	"	"	"	" "	"	"		3	" "	"	"						
	This Paint Spreads Best at 1200 sq ft per Gallon.																			
THIRD COAT	1	Oct. 11	50°	38°	82	40	72 hours	30.51	1/200		1	Oct. 11	50°	3						
Weight per gal. 13.452 lb.	2	" "	"	"	"	"	" "	"	"		2	" "	"	"						
Specific Gravity 1.61	3	" "	"	"	"	"	" "	"	"		3	" "	"	"						
	This Paint Spreads Best at 1200 sq ft per Gallon.																			

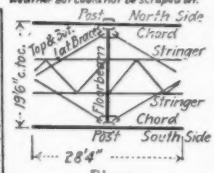
G TEST ON SECTION NO. 17.

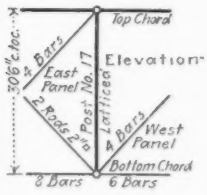


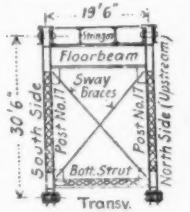
less.

Note: (Surfaces where wire brush could not be used are not included in the test.

The shop coat of black on the floor beams and truss bars, is soft in warm weather but could not be scraped off.







June-----/06 in ½ bbl. containers.
room. Price per gallon.---------
ned ½ bbl very little separation a
xture, medium thin, easily applied,
ttle slow. Sets enough to be safe
0 hours. This coat applied to all sur-
he top side of floor system which
Red lead before the truck was laid.
shows on the nuts and pins of the
ons, and along the flange and stiff-
f the floor beams and stringers
side of top chords.

ned ½ bbl. Same color and con-
coat.
e skin forms in ½ bbl. in 36 hours.
s even coat, good gloss. Shows poor
n inside of North chord in West panel.
me surfaces as 1st coat.

ned same ½ bbl. as 2nd coat, as
d same marks, except 1st coat.
orking conditions same as

s good gloss and an even coat, ex-
e of North chord which had too
n 1st coat not well brushed out.
me surfaces as 1st coat, except o-
ide of top chords.

Condition of Steel.

After using sharp (chisel edge) hand scrapers, followed by stiff steel wire brushes, by men on plank between the top chords and stringers and on the regular staging (as noted below), there remained the following percentage of the surfaces covered with the shop coat of black

All top surfaces of horizontal plates and bracing are all exposed and rusty, but smooth. All field rivets were never painted, sides of bottom strut 50% and also rust and scales, top of strut all rust. Everything loose was removed and surface left clean and hard. All not noted above were 70 to 90%

The paint was applied as follows, (a) from a 4 man staging working from the top down to bottom struts, (two men on sec. 17 and two on the adj. sec.), (b) two men on a plank across (below) the bottom bracing and chords, (c) two men on a plank slung from end of track timbers for outside of top chords.

Brushes used were round pound brushes, except sheep skin swabs in narrow places between the eye bars, and long handle double round brushes in the latticed box girders and chairs. All brushes were new or nearly so and carefully cleaned for each change.

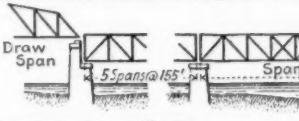
Nov. 13 to 15, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x 5/8" ± (No. 10 Gage), Weight 35 lb. ±

D OF PLATE TESTS.

Spreading Rate of 900 sq. ft. per Gallon.									Spreading Rate of 600 sq. ft. per Gallon.								
te 06	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.	Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
t. 14	78°	73°	86	61	24 hours	36.06	1/150	1	Sept 14	78°	73°	86	61	24 hours	54.08	1/100
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"
t. 26	72°	57°	82	69	48 hours	40.15	1/150	1	Sept. 26	72°	57°	82	69	48 hours	60.22	1/100
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"
11	50°	38°	82	40	72 hours	4068	1/150	1	Oct 11	50°	38°	82	40	72 hours	61.02	1/100
"	"	"	"	"	" "	"	"	2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"	3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST ON

HAVRE DE GRACE



Paint was applied only when humidity was 85 or less

Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
		First Coat							gal.	lb.	sq.ft.	sq.ft.	Weather record is for 7^30 A.M. to 5^30 P.M.
Sept. 12	6.25	0	Clear	93	79	81	72	0	0				Cleaning the surface
" 13	36.50	0	Fair	91	76	82	75	0	0				" " "
" 14	17.25	0	Cloudy	86	61	73	73	0	0				" " "
" 15	2.50	1^00 to 4^00	"	66	64	68	61	4.	2.72				Painting West panel top ins. and outs.
" 16	0	Sunday	"	74	65	68	57	0	0				Sunday
" 17	3.	7^30 to 5^30	Fair	84	72	73	61	22	4.96				East panel 1/2 down West panel completed
" 18	0	8^15 to 11^30	"	90	84	77	69	5.50	1.88				Strut and East panel comp.
" 19	0	0	"	95	77	82	73	0	0				Sec. completed 11 A.M. 18
Totals	60.50							31.50	9.56	8254	511	4891	Foreman's time omitted
		Second Coat											
Sept. 27		0	Light rain	97	79	72	67	0	0				
" 28		8^30 to 5^00	Clear	71	54	74	62	11.50	1.08				West panel
" 29		9^00 to 4^00	Cloudy	87	69	75	64	15.25	2.51				East panel and bot. strut
" 30		Sunday	"	71		67		0	0				Sunday
Oct. 1		8^30 to 9^00	Showers	83	70	58	52	2.50	0.39				Bottom work & top outside
" 2		0	"	88	71	67	56	0	0				Sec. completed 9 A.M. 1st Oct.
Totals								30.25	4.98	3162	982	4891	Foreman's time omitted
		Third Coat						Downstream			Half	of Section	
Oct. 9		0	Fair	87	69	70	57	0	0				
" 10		9^30 to 10^00	"	85	53	53	42	1.	0				Moving stagings
" 11		7^30 to 5^00	"	82	40	47	38	10.50	2.63				Both panels and top outside
" 12		3^30 to 5^00	Clear	78	50	50	31	4.50	0.71				Bottom work
" 13			"	83	34	57	39	0	0				Section completed 5 P.M. Oct. 5
Totals								16.	3.40	8213	1019	3464	Foreman's time omitted

Paint received June /06 in 5
Color Black. Price ..... p
Sept. 14, opened 1/2 bbl. mix
considerable separation,
a heavy body.
First coat was applied to all
except the top side of floor s
painted Red Lead before tr
also shows on the nuts and
connections and along the
fener angles of the floor bea
and insides of the top chor
This paint dries slowly, is sti

Sept. 27 opened 1/2 bbl. Sam
as 1st coat and same wor
except dries in 24 hr. Quite
coat applied to same surfa

Third coat on downstream ha
the foreman also on upstream hal
the bottom chord and the outsid
reopened 1/2 bbl. used on seco
same working conditions as b
applied on inside of top chord
even black coat with consid
tice bar edges, and on top s
plates where cinders were

SEC. No. 18.

Note:
Test Plates in Triplicate.
3 for each Spreading Rate.
Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record
Humidity " " " " "

RECORD OF PLATE

	Plate No.	Date 1906	Temp. Fahr. Max.	Temp. Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
FIRST COAT Weight per gal. 8.254 lb. Specific Gravity 0.99	1	Sept. 17	70	61	84	72	24 hours	18.12	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.								
SECOND COAT Weight per gal. 8.162 lb. Specific Gravity 0.98	1	Sept. 28	72	62	71	54	48 hours	18.51	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.								
THIRD COAT Weight per gal. 8.273 lb. Specific Gravity 0.99	1	Oct. 12	54	35	78	50	48 hours	18.77	1/200
	2	" "	"	"	"	"	" "	"	"
	3	" "	"	"	"	"	" "	"	"
	This Paint Spreads Best at 1200 sq ft per Gallon.								

Spreading Ra

Plate No.	Date 1906	Temp. Fah. Max.	Temp. Fah. Mi
1	Sept. 17	70	61
2	" "	"	"
3	" "	"	"
1	Sept. 28	72	6
2	" "	"	"
3	" "	"	"
1	Oct. 12	54	3
2	" "	"	"
3	" "	"	"

G TEST ON SECTION No. 18.

Section No. 18
East End
Span 4. 155'
Span 3. 155'
Span 2.
Span 1.
PERRYVILLE
Note: Surfaces not accessible for wire brushes are not to be included in the test comparisons.

The shop coat of black on the floorbeam and stringers and chord bars is soft in warm weather but could not be scraped off.

June /06 in ½ bbl. containers.
Price ..... per gallon.
½ bbl. mixture even and no separation, easily applied, not

applied to all accessible surfaces side of floor system which was ad before track laying. Red Lead the nuts and pins of the post nd along the flange and stif - the floor beams and stringers the top chords.
s slowly, is sticky the third day.

½ bbl. Same color and mixture d same working conditions 24 hr. Quite firm in 48 hr. This same surfaces as 1st coat.

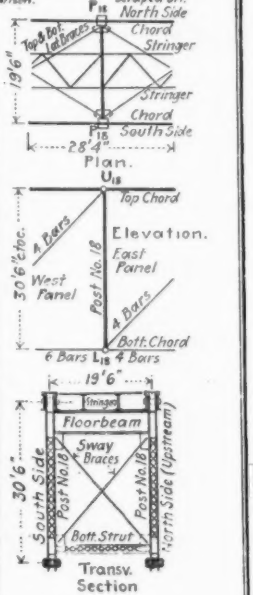
ownstream half and by mistake of n upstream half of west panel (except and the outside of top chord) Oct. 10 used on second coat and found onditions as before. No 3rd coat e of top chord Oct 13 shows an t with considerable gloss on lat- and on top sides of connection tringers were brushed in.

Condition of Steel.

After cleaning all surfaces with sharp (chisel edge) scrapers followed by stiff steel wire brushes by men on plank between the top chords and the stringers, and on the stagings noted below. There remained about the following percentage of surface covered with the shop coat of black. Top chords, stringers and floorbeams 90% on sides, 40% on underside of horizontal flanges. Top bracing 60%. Bottom bracing 40%. South post 50% on sides 40% on lattice bars. North post 90% Bottom strut 30%. Do. bracing all rust. Top bracing 60%. Field rivets never painted All horizontal conn. plates all rust

Paint was applied as follows (a) from 4 man stagings suspended from the track timbers (2 men on sec. 18 and 2 on the adjacent sections) (b) two men on a plank that is hung across (below) the bottom chords. (c) two men on a plank for the outsides of the top chords.

Brushes used were round one pound brushes, except sheepskin swabs in the narrow places and long handle double round brushes inside the box girders and chairs New brushes on 1st coat.



D OF PLATE TESTS

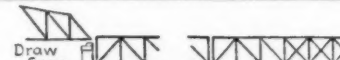
Nov. 13 to 15, '06 *Plates were Placed on South Bottom Chord of Bridge*
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

Spreading Rate of 900 sq. ft. per Gallon.									Spreading Rate of 600 sq. ft. per Gallon.								
te 06	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.		Plate No.	Date 1906	Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.
17	70	61	84	72	24 hours	24.96	1/150		1	Sept. 17	70	61	84	72	24 hours	37.44	1/100
"	"	"	"	"	" "	"	"		2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"		3	" "	"	"	"	"	" "	"	"
28	72	62	71	54	48 hours	24.71	1/150		1	Sept. 28	72	62	71	54	48 hours	37.02	1/100
"	"	"	"	"	" "	"	"		2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"		3	" "	"	"	"	"	" "	"	"
12	54	35	78	50	48 hours	25.03	1/150		1	Oct. 12	54	35	78	50	48 hours	37.54	1/100
"	"	"	"	"	" "	"	"		2	" "	"	"	"	"	" "	"	"
"	"	"	"	"	" "	"	"		3	" "	"	"	"	"	" "	"	"

RECORD OF PAINTING TEST ON SE

Date '06	No. of Hours Cleaning	Time of Day Painting	Weather	Max. Humidity	Min. "	Max. Temperature	Min. "	No. of Hours Painting	Amt. of Paint Used	Weight of Paint per Gal.	Area Covered per Gal.	Total Area Covered	
									Gal.	Lb.	Sq. ft.	Sq. ft.	
	First Coat												
Sept. 13	16.00		Fair	91	76	82	75	0	0				Cleaning steel.
" 14	23.50		Cloudy	86	61	73	73	0	0				" "
" 15	0	7 15 to 9 15	"	66	64	68	61	16.00	4.08				East panel 3/4 down.
" 16	0	Sunday	"	74	65	68	57	0	0				Sunday.
" 17	4.00	7 15 to 4 15	Clouds AM Clear PM	84	72	73	61	9.00	4.47				Both panels & top outside.
" 18	4.00	9 00 to 3 15	Fair	90	84	76	69	12.50	1.45				Bottom chord & braces.
" 19	0		Rain 8 A.M. to 2 P.M.	95	77	82	73	0	0				Sec. completed 3.30 PM. 18th.
Totals	47.50			71		67		47.50	10.00	8.02	463	4628	Foreman's time omitted.
	Second Coat.												
Sept. 28		0	Clear	71	54	74	62	0	0				
" 29		6 00 to 4 00	Cloudy	83	69	73	67	13.00	2.74				West panel to bottom.
" 30		Sunday	Clouds	71		67		0	0				East panel & top outsides.
Oct. 1		9 00 to 5 00	It's showers	83	70	58	52	15.75	3.60				Bottom chords & braces.
" 2		0	Cloudy	88	71	67	56	0	0				Sec. completed 5 PM. Oct. 1.
Totals								28.75	6.34	8.12	730	4628	Foreman's time omitted.
	Third Coat.			On	down	stream	half	only					
Oct. 10		0	Fair	96	53	53	42	0	0				
" 11		12 15 to 4 00	"	82	46	47	38	10.50	1.71				W. panel to bot. & pan top inside.
" 12		7 15 to 12 15	Clear	78	50	50	37	7.50	0.63				All except bot. & batter post.
" 13		8 00 to 9 00	"	83	34	57	39	0.25	0.01				Completed.
" 14		0	"	76	29	74	48	0	0				Sec. completed 9 A.M. Oct. 13.
Totals								18.25	2.35	8.72	840	1975	Foreman's time omitted.

HAVRE DE GRACE



Paint was applied only when humidity was 85 or less

Paint received June /06 in 1/2 bbl. c
Color, Black. Price -
Sept. 13th. opened 1/2 bbl. A thin e
Spreads freely. Requires care to
much paint on. No separation a
on surface of mixture in 24 hr.
1st. coat dries slowly, 56 hours to
Applied to all accessible surface
side of floor system which was
Lead before the track was laid.
By mistake in painting the outside
of sec. 18, 4 ft. of surface of 19 was
18 paint at West end of South top

Sept. 28th. opened 1/2 bbl. Same m
coat and same working condition
quicker. Dries in 72 hours.
Applied to same surfaces as firs
skin on surface in 1/2 bbl. in 36 hr.
Note: A shop coat of Red Lead
inside of top chord and on post pl
also under floorbeam and string

Oct. 10th. reopened second coat 1/2
change in mixture. Working co
as previous coat. Dries in 72 ho
firm, easily rubbed off.
Third coat applied only on down
except the floorbeam has three
width of West panel.
Third coat omitted from inside
and no long handle brushes us

SEC. No. 19.

Note: Test Plates in Triplicate: 3 for each Spreading Rate.
{ Max. Temp. is for the Paint Room.
Min. " " from Daily Outside Record.
Humidity " " " " "

RECORD OF PLATE TES

	Plate No.	Date 1906	Spreading Rate of 1200 sq. ft. per Gallon. Temp., Fahr. Max.	Temp., Fahr. Min.	Humidity Max.	Humidity Min.	Time req'd to Dry	Paint Used q.	Paint Used gal.	Plate No.	Date 1906	Spreading Rate Temp., Fahr. Max.	Spreading Rate Temp., Fahr. Min.
First Coat	1	Sept. 17	80	61	84	72	36 hours	18.19	1/200	1	Sept. 17	80	61
Weight per gal. 8.02 lb.	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 0.963	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint had to be flowed on at 1200 sq. ft. per gal.												
Second Coat	1	Sept. 28	79	62	71	54	96 hours	18.42	1/200	1	Sept. 28	79	62
Weight per gal. 8.122 lb.	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 0.980	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint had to be flowed on at 1200 sq. ft. per gal.												
Third Coat	1	Oct. 12	54	37	78	50	120 hours	18.86	1/200	1	Oct. 12	54	37
Weight per gal. 8.227 lb.	2	" "	"	"	"	"	" "	"	"	2	" "	"	"
Specific Gravity 0.990	3	" "	"	"	"	"	" "	"	"	3	" "	"	"
	This Paint had to be flowed on at 1200 sq. ft. per gal.												

EST ON SECTION No. 19.

Note: Surfaces not accessible for wire brushes are omitted in the test comparison.

The shop coat of black is soft in warm weather especially on the lower bars but could not be scraped off.

/06 in ½ bbl. containers.
Price ----- per gallon.
bbl. A thin even mixture
quires care to not get too
separation and no skin forms
ure in 24 hr.
ly, 56 hours to dry.
sible surfaces except the top
m which was painted Red
ack was laid.
ng the outside of the top chord
ace of 19 was covered with sec.
of South top chord (outside).

bbl. Same mixture as first
ing conditions except sets
hours.
rfaces as first coat slight
bbl. in 36 hr.
t of Red Lead was applied to
and on post pin connections
m and stringer angles.

second coat ½ bbl. found no
. Working conditions same
Dries in 72 hours but is not
d off.
only on down stream half
am has three coats on full
el.
d from inside of top chord
le brushes used.

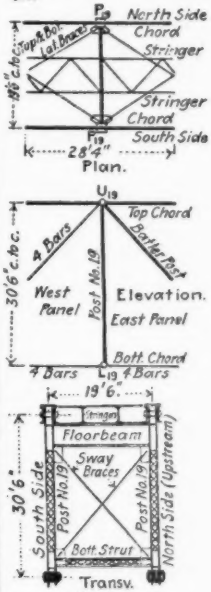
Condition of Steel.

After using sharp (chisel edge) hand scrapers followed by stiff steel wire brushes by men on plank beteen the top chords and stringers, and on the regular stagings as noted below, there remained the following percent of surface covered with the shop coat of black.

Batter posts on sides and bottom 90% but rough, sides of bottom strut and bracing 30%, top and bottom all rust. North col. outside all rust. South post inside 50% and rough, field rivets were never painted and splice plates and other hor. horizontal surfaces are all rust. All other surfaces are from 70 to 90% covered. Everything loose was removed by scrapers and wire brushes.

The paint was applied as follows (a) from 4 man staging suspended from the track timber (2 men working on sec. 19 and 2 on the adj. sec.) (b) two men on a plank across (below) the bottom bracing and chords (c) two men on a plank slung at ends of track timbers for top outside of truss chords.

Brushes used were round pound brushes, except sheepskin swabs in narrow places between eye bars, & long handle double round brushes in latticed girders & chairs.



Nov. 13 to 15, '06 Plates were Placed on South Bottom Chord of Bridge.
Nine Plates Used.
Size 36" x 24" x ⅜" ± (No. 10 Gage), Weight 35 lb. ±

PLATE TESTS.

Spreading Rate of 900 sq. ft. per Gallon.								Spreading Rate of 600 sq. ft. per Gallon.									
Temp., Fahr.		Humidity		Time req'd to Dry	Paint Used			Plate No.	Date 1906	Temp., Fahr.		Humidity		Time req'd to Dry	Paint Used		
Max.	Min.	Max.	Min.		q.	gal.				Max.	Min.	Max.	Min.		q.	gal.	
80	61	84	72	36 hours	24.25	1/150		1	Sept. 17	88	61	84	72	36 hours	36.38	1/100	
"	"	"	"	"	"	"		2	" "	"	"	"	"	"	"	"	
"	"	"	"	"	"	"		3	" "	"	"	"	"	"	"	"	
79	62	71	54	96 hours	24.56	1/150		1	Sept. 28	79	62	71	54	96 hours	36.84	1/100	
"	"	"	"	"	"	"		2	" "	"	"	"	"	"	"	"	
"	"	"	"	"	"	"		3	" "	"	"	"	"	"	"	"	
54	37	78	50	120 hours	24.88	1/150		1	Oct. 12	54	37	78	50	120 hours	37.32	1/100	
"	"	"	"	"	"	"		2	" "	"	"	"	"	"	"	"	
"	"	"	"	"	"	"		3	" "	"	"	"	"	"	"	"	

mittee and not to be derived from a study of the most complete analyses but probably within the knowledge of the manufacturers, the unsatisfactory conditions imposed through the manufacturers' refusal to answer the original questions became so apparent that informal attempts were made from time to time to sound the manufacturers regarding the possibility of their meeting the committee's wishes. But with the development of the tests, it became more and more apparent that such information as desired by the committee could only have been obtained as originally proposed at the time of inauguration of the tests.

The test logs of the several paints published herewith give detailed information regarding the conduct of the tests which, as originally stated, was aimed to be "eminently fair to each competitor and to the paints themselves." The annual inspections were carefully carried out, all ratings being with the same scale, and detailed examination of yearly reports will demonstrate the surprising concordance of these with conditions likely to exist. Tables I and II are compilations of the annual ratings assembled somewhat differently than heretofore. These show the life length of each paint in each class, and more positively rate each paint individually than has been possible until the completion of the test. The real value of the method of marking and the conscientious work of the inspections are indicated; also shown by the higher values of the ratings generally appearing when the period covered is shorter for any one class. The latter of course is influenced by the subsequent lower class ratings of each paint.

No attempt has been made in the reports on the Havre de Grace bridge tests to give full information as to the prices of the paints used, although it is recognized that engineers must consider price in figuring the cost of protection against rust. The log sheets published in Plates III to XXI, inclusive, give some information on this subject.

Respectfully submitted on behalf of the sub-committee,

W. A. AIKEN,
Chairman.

APPENDIX.

DESCRIPTIONS OF PAINTS BY SUB-COMMITTEE BASED ON ANALYSES AND THOSE SUGGESTED BY MANUFACTURERS.

Paint No 1.

Committee Description.—This paint applied to first and second coats. No third coat. On the first coat an iron-oxide paint, containing some red lead in a vehicle of long-oil varnish thinned with turpentine. The second coat similar to the first coat except that carbon pigment was added.

Description Suggested by Manufacturer.—No reply received from manufacturer.

Paint No. 2.

Committee Description.—Same for all three coats. This is a graphite-silicate paint, ground in linseed oil and thinned with light mineral oil containing a little turpentine.

Description Suggested by Manufacturer.—Reply received but no change suggested.

Paint No. 3.

Committee Description.—First coat is a carbon paint ground in linseed oil and thinned with turpentine. In the body coat the pigment is composed of zinc oxide, basic sulfate of lead, basic carbonate of lead, and a small amount of silicious matter and carbonaceous matter ground in linseed oil, and thinned with a mixture of turpentine and light mineral oil. The finishing paint is a mixture of calcium sulfate and oxide of iron with a small amount of carbonaceous matter ground in linseed oil. Three coats applied.

Description Suggested by Manufacturer.—Reply received but no change suggested.

Paint No. 4.

Committee Description.—Paint the same for all three coats. Carbonaceous paint containing a small amount of red lead, ground in linseed oil and thinned with turpentine.

Description Suggested by Manufacturer.—Reply received but no change suggested.

Paint No. 5.

Committee Description.—Same for all three coats. The pigment is largely carbonaceous matter with considerable red lead, ground in linseed oil and thinned with a mixture of turpentine and light mineral oil.

Description Suggested by Manufacturer.—Reply received suggesting the following description:

Charcoal	19	per cent
Red lead	9	"
Linseed oil	64	"
Drier	8	"

Composition the same for all three coats.

PAINT NO. 6.

Committee Description.—The first coat is red lead with some magnesium silicate in a vehicle of linseed oil. The second coat is similar to the first, except that it contains 15 to 20 per cent carbon pigment. The third coat is a carbon pigment containing a small amount of red lead and silicate, ground in linseed oil thinned with turpentine containing a little light mineral oil. Three coats applied.

Description Suggested by Manufacturer.—Reply received suggesting the following description: The first coat is red lead with some magnesium silicate in a vehicle of prepared linseed oil. The third coat is a carbon-pigment paint containing a small amount of red lead and silicate, ground in prepared linseed oil containing a little mineral naphtha. The second coat is a mixture of the first and third coats.

PAINT NO. 7.

Committee Description.—Same for all three coats. The paint consists of carbonaceous matter, probably graphite, silicate, and lithopone, ground in linseed oil, thinned with light mineral oil containing some turpentine and oil of camphor.

Description Suggested by Manufacturer.—Reply received but no change suggested.

PAINT NO. 8.

Committee Description.—Same for all three coats. The paint is artificial graphite (containing over 90 per cent graphitic carbon) in a vehicle of linseed oil thinned with turpentine and some light mineral oil.

Description Suggested by Manufacturer.—Reply received suggesting the following description:

Acheson graphite	34	per cent
Linseed oil	54	"
Turpentine	4	"
Dryer	8	"

Composition same for all three coats.

PAINT NO. 9.

Committee Description.—All three coats very similar. This paint consists of siliceous material, oxide of iron, and carbon pigments probably graphite, in a vehicle of linseed oil thinned with a small amount of light material oil with perhaps some turpentine. The percentage of carbon pig-

ment is higher in the second coat than in the first, and higher in the third coat than in the second.

Description Suggested by Manufacturer.—Reply received. Manufacturer states that this was an experimental paint and has never been manufactured commercially.

PAINT NO. 10.

Committee Description.—First and second coats red lead and linseed oil. Third coat red lead and small amount of carbon pigments in linseed oil. The red lead used showed on analysis 88.5 per cent true red lead (Pb_3O_4). Three coats applied.

Description Suggested by Manufacturer.—Reply received but no change suggested except that manufacturer requests that complete analysis of this product be given—this was published in the report of Committee D-1 for 1908.

PAINT NO. 11.

Committee Description.—The first and second coats red lead in linseed oil. The third coat red lead and a very small amount of carbon pigment in linseed oil. The red lead used showed on analysis 95.9 per cent true red lead (Pb_3O_4). Three coats applied.

Description Suggested by Manufacturer.—Reply received but no change suggested.

PAINT NO. 12.

Committee Description.—The paint used on the first coat was a mixture of calcium silicate, zinc oxide, and sublimed blue lead in linseed oil. The second and third coats are carbon paints containing some red lead and silicates ground in linseed oil and thinned with turpentine. Three coats applied.

Description Suggested by Manufacturer.—Reply received suggesting the following description: The paint used for the first coat was a mixture of calcium tri-silicate, zinc oxide, and sublimed lead in a linseed and Chinese wood oil vehicle. The second coat was a carbon paint containing some lead oxide and silicate of alumina ground in linseed and prepared Chinese wood oil, thinned with a small percentage of turpentine.

The analysis of the pigment of the first coat is as follows:

Basic lead sulfate and zinc oxide	50	per cent
Calcium tri-silicate	50	"
Total	100	"

PAINT NO. 13.

Committee Description.—Same for all three coats. This is a natural graphite paint ground in linseed oil and thinned with turpentine containing a very small percentage of light mineral oil.

Description Suggested by Manufacturer.—Reply received but no change suggested, except that manufacturer states that no mineral oil was used in the preparation of this paint.

PAINT NO. 14.

Committee Description.—The paint used for the first coat is a mixture of red lead and silicious material ground in linseed oil. The paint for the second and third coats was a carbon pigment with possibly a very small amount of red lead in linseed oil. Three coats applied.

Description Suggested by Manufacturer.—Reply received but no change suggested.

PAINT NO. 15.

Committee Description.—Same for all three coats. The paint was a bituminous material thinned with light mineral oil.

Description Suggested by Manufacturer.—No reply received from manufacturer.

PAINT NO. 16.

Committee Description.—Same for all three coats. Silicate-graphite paint with linseed oil, thinned with light mineral oil and turpentine.

Description Suggested by Manufacturer.—Reply received suggesting the following description:

Carbon (graphite)	20.00 per cent
Silica and silicates	26.50 "
Linseed oil	27.75 "
Varnish	4.25 "
Turpentine	4.25 "
Japans	17.25 "

Composition the same for all three coats.

PAINT NO. 17.

Committee Description.—Same for all three coats. The paint was a mixture of oxide of iron, barium sulfate, and silicious material with a small amount of carbon pigment, ground in linseed oil and thinned with turpentine.

Description Suggested by Manufacturer.—Reply received suggesting the following description: The paint is an oxide of iron and carbon paint in a straight linseed-oil vehicle with turpentine drier, and has the following composition:

Paint	Pigment	53.9 per cent	Ferric oxide	48.6 per cent
			Carbon	8.8 "
			Barium sulfate	40.0 "
			Silica	2.6 "
	Vehicle	46.1 per cent	Linseed oil	89.2 per cent
			Turpentine drier	10.8 "

PAINT NO. 18.

Committee Description.—Same for all three coats. The paint was chiefly a carbon pigment with some lead sulfate and a small amount of silicious material, ground in linseed oil and thinned with a mixture of light mineral oil and turpentine.

Description Suggested by Manufacturer.—Reply received suggesting the following description:

Same for all three coats. The pigment portion of the paint consisted of gas carbon black and sublimed white lead; the vehicle portion, of a specially treated linseed oil and Japan drier.

PAINT NO. 19.

Committee Description.—Same for all three coats. Paint was a carbon pigment with a small amount of red lead, in a vehicle of linseed oil thinned with turpentine.

Description Suggested by Manufacturer.—Reply received but no change suggested.

TABLE I.—CLASSIFICATION BY PANEL RESULTS BASED ON AVERAGE CONDITIONS.

Paint No.	Class I, Excellent (8–10).		Class II, Good (6–8).		Class III, Fair (4–6).		Class IV, Poor (2–4).		Class V, Failed (0–2).	
	Average Grade.	Time in Class I, years.	Average Grade.	Time in Class II, years.	Average Grade.	Time in Class III, years.	Average Grade.	Time in Class IV, years.	Average Grade,	Time in Class V, years.
11	8.7	7½	...	..	...	..	...	..	...	..
10	8.8	5½	6.0	2	...	..	...	..	...	..
6	9.0	4½	7.6	3	...	..	...	..	...	..
12	9.0	4½	6.7	3	...	..	...	..	...	..
14	8.7	4½	6.8	3	...	..	...	..	...	..
5	8.5	4½	6.9	3	...	..	...	..	...	..
18	8.9	4½	7.5	1	4.5	2	...	..	...	..
16	8.8	4½	6.5	1	4.3	2	...	..	...	..
8	8.5	4½	6.7	1	5.1	2	...	..	...	..
4	8.8	3½	7.6	1	5.0	3	...	..	...	..
7	8.7	3½	7.9	1	5.1	1	2.5	2	...	..
10	8.8	3½	7.3	1	5.9	1	3.4	2	...	..
13	8.1	3½	7.5	1	4.6	1	2.0	2	...	..
9	8.6	3½	7.9	1	...	..	3.5	1	0.4	2
3	...	..	7.1	5½	5.8	2	...	..	...	..
17	...	..	7.3	5½	4.1	2	...	..	...	..
1	...	..	6.9	5½	5.5	2	...	..	...	..
2	...	..	...	..	5.5	4½	...	..	1.0	3
15	...	..	...	..	...	..	2.9	4½	0.6	3

NOTE.—To illustrate this table, paint No. 19 was in Class I for 3½ years, in Class II for 1 year, in Class III for 1 year and in Class IV for 2 years, based on average inspection rates (See Table II.)

TABLE II.—CLASSIFICATION BY PANEL RESULTS BASED ON AVERAGE CONDITIONS, WITH DESCRIPTION OF PAINT COMPOSITIONS.

PAINT No. 11..Rated in Class I.....Excellent from date of application to end of test, 7½ years.
Priming and Body Coats (1st and 2d)..Red lead (95.9% Pb_3O_4) in linseed oil.
Finishing Coat (3d)...Same red lead with small amount of carbon pigment in linseed oil.

PAINT No. 10..Rated in Class I.....Excellent from date of application for 5½ years.
Rated in Class II.....Good thereafter to end of test, 2 years.
Priming and Body Coats (1st and 2d)..Red lead (88.5% Pb_3O_4) in linseed oil.
Finishing Coat (3d)...Same red lead with small amount of carbon pigment in linseed oil.

PAINT No. 6..Rated in Class I.....Excellent from date of application for 4½ years.
Rated in Class II.....Good thereafter to end of test, 3 years.
Priming Coat (1st)...Red lead with some magnesium silicate in linseed oil.
Body Coat (2d).....Red lead with some magnesium silicate and 15 to 20% carbon pigment in linseed oil.
Finishing Coat (3d)...Carbon pigment with small amount of red lead and silicate in linseed oil thinned with turpentine containing a little light mineral oil.

PAINT No. 12..Rated in Class I.....Excellent from date of application for 4½ years.
Rated in Class II.....Good thereafter to end of test, 3 years.
Priming Coat (1st)...Mixture of calcium silicate, zinc oxide and sublimed blue lead in linseed oil.
Body and Finishing Coats (2d and 3d)..Carbon paint containing some red lead and silicate in linseed oil thinned with turpentine.

PAINT No. 14..Rated in Class I.....Excellent from date of application for 4½ years.
Rated in Class II.....Good thereafter to end of test, 3 years.
Priming Coat (1st)...Red lead and silicious material in linseed oil.
Body and Finishing Coats (2d and 3d)..Carbon pigment with possibly small amount of red lead in linseed oil.

TABLE II.—*Continued.*

PAINT NO. 5	Rated in Class I	Excellent from date of application for 4½ years.
	Rated in Class II	Good thereafter to end of test, 3 years.
	Priming, Body and Finishing Coats (1st, 2d and 3d) identical	Largely carbonaceous with considerable red lead in linseed oil thinned with mixture of turpentine and light mineral oil.
PAINT NO. 18	Rated in Class I	Excellent from date of application for 4½ years.
	Rated in Class II	Good thereafter for 1 year.
	Rated in Class III	Fair thereafter to end of test, 2 years.
	Priming, Body and Finishing Coats (1st 2d and 3d) identical	Chiefly carbon pigment with some lead sulfate and small amount of silicious material in linseed oil thinned with mixture of turpentine and light mineral oil.
PAINT NO. 16	Rated in Class I	Excellent from date of application for 4½ years.
	Rated in Class II	Good thereafter for 1 year.
	Rated in Class III	Fair thereafter to end of test, 2 years.
	Priming, Body and Finishing Coats (1st, 2d and 3d) identical	Silicate graphite paint in linseed oil thinned with mixture of turpentine and light mineral oil.
PAINT NO. 8	Rated in Class I	Excellent from date of application for 4½ years.
	Rated in Class II	Good thereafter for 1 year.
	Rated in Class III	Fair thereafter to end of test, 2 years.
	Priming, Body and Finishing Coats (1st, 2d and 3d) identical	Artificial graphite (over 90% graphitic carbon) in linseed oil thinned with mixture of turpentine and light mineral oil.
PAINT NO. 4	Rated in Class I	Excellent from date of application for 3½ years.
	Rated in Class II	Good thereafter for 1 year.

TABLE II.—*Continued.*

PAINT NO 4 (*Continued*).
Rated in Class III....Fair thereafter to end of test, 3 years.
Priming, Body and Finishing Coats (1st, 2d and 3d) identical. Carbonaceous pigment with small amount of red lead in linseed oil thinned with turpentine.

PAINT NO. 7..Rated in Class I.....Excellent from date of application for 3½ years.
Rated in Class II.....Good thereafter for 1 year.
Rated in Class III....Fair thereafter for 1 year.
Rated in Class IV....Poor thereafter to end of test, 2 years.
Priming, Body and Finishing Coats (1st, 2d and 3d) identical. Carbonaceous pigment (probably graphite) silicate and lithopone in linseed oil thinned with light mineral oil, some turpentine and oil of camphor.

PAINT NO. 19..Rated in Class I.....Excellent from date of application for 3½ years.
Rated in Class II.....Good thereafter for 1 year.
Rated in Class III....Fair thereafter for 1 year.
Rated in Class IV....Poor thereafter to end of test, 2 years.
Priming, Body and Finishing Coats (1st, 2d and 3d) identical. Carbon pigment with small amount of red lead in linseed oil thinned with turpentine.

PAINT NO. 13..Rated in Class I.....Excellent from date of application for 3½ years.
Rated in Class II.....Good thereafter for 1 year.
Rated in Class III....Fair thereafter for 1 year.
Rated in Class IV....Poor thereafter to end of test, 2 years.
Priming Body and Finishing Coats (1st, 2d and 3d) identical. Natural graphite pigment in linseed oil, thinned with turpentine containing a very small percentage of light mineral oil.

PAINT NO. 9..Rated in Class I.....Excellent from date of application for 3½ years.
Rated in Class II.....Good thereafter for 1 year.

TABLE II.—*Continued.*

PAINT NO. 9 (*Continued*).

Rated in Class IV....Poor thereafter for 1 year.
Rated in Class V.....Failed thereafter to end of test, 2 years.
Priming, Body and Finishing Coats (1st, 2d and 3d) identical, save for increasing percentages of carbon.....Silicious material, oxide of iron and carbon pigment in linseed oil thinned with small amount of light mineral oil and perhaps some turpentine.

PAINT NO. 3..Rated in Class II.....Good from date of application for 5½ years.
Rated in Class III....Fair thereafter to end of test, 2 years.
Priming Coat (1st)...Carbon pigment in linseed oil thinned with turpentine.
Body Coat (2d).....Zinc oxide, basic sulfate of lead, basic carbonate of lead and small amount of silicious and carbonaceous matter in linseed oil thinned with turpentine and light mineral oil.
Finishing Coat (3d)...Calcium sulfate and oxide of iron with small amount of carbonaceous matter in linseed oil.

PAINT NO. 17..Rated in Class II.....Good from date of application for 5½ years.
Rated in Class III....Fair thereafter to end of test, 2 years.
Priming, Body and Finishing Coats (1st, 2d and 3d) identical.Oxide of iron, barium sulfate and silicious material with small amount of carbon pigment in linseed oil, thinned with turpentine.

PAINT NO. 1..Rated in Class II.....Good from date of application for 5½ years.
Rated in Class III....Fair thereafter to end of test, 2 years.
Priming Coat (1st)...Iron-oxide pigment with some red lead in a long-oil varnish thinned with turpentine.
Finishing Coat (2d)...Iron-oxide pigment with some red lead with carbon pigment added in a long-oil varnish thinned with turpentine.

TABLE II.—*Continued.*

PAINT NO. 2..	Rated in Class III....	Fair from date of application for 4½ years.
	Rated in Class V.....	Failed thereafter to end of test, 3 years.
	Priming, Body and Finishing Coats (1st, 2d and 3d) identical.	Graphite silicate paint in linseed oil thinned with light mineral oil and a little turpentine.
PAINT NO. 15..	Rated in Class IV....	Poor from date of application for 4½ years.
	Rated in Class V.....	Failed thereafter to end of test, 3 years.
	Priming, Body and Finishing Coats (1st, 2d and 3d) identical.	Bituminous material thinned with light mineral oil.

REPORT OF SUB-COMMITTEE III ON TESTING OF PAINT VEHICLES.

The work of the sub-committee during 1912 to 1914 developed sufficient data regarding the constants of Chinese wood oil to warrant specifications for this product. It was thought advisable, however, to await the results of newly devised and confirmatory tests before issuing such specifications. These new tests have therefore been under investigation during the past year, especially with a view of determining their value in detecting small percentages of adulterants in Chinese wood oil. The results of these tests are presented in this report.

TESTS ON COMMERCIAL CHINESE WOOD OIL AND OIL MIXTURES.

Five 4-oz. oil sample bottles, numbered from 1 to 5, containing Chinese wood oil and Chinese-wood-oil mixtures, were sent to each member of the sub-committee who had expressed himself as willing to perform the work. A description of the samples and the tests outlined for them are indicated in the following letter sent out to the observers:

WASHINGTON, D. C.
Jan. 21, 1915.

To the Members of Sub-Committee III.

Gentlemen:

I am sending you by express a box containing samples of Chinese wood oil for test. These samples are numbered from 1 to 5. The composition of these wood oils is as follows:

Oil No. 1, pure Chinese wood oil;
Oil No. 2, 95 per cent Chinese wood oil, 5 per cent soya bean oil;
Oil No. 3, 90 per cent Chinese wood oil, 10 per cent soya bean oil;
Oil No. 4, 95 per cent Chinese wood oil, 5 per cent linseed oil;
Oil No. 5, 90 per cent Chinese wood oil, 10 per cent linseed oil.

These samples were prepared on Wednesday, Jan. 20, 1915, by Mr. E. W. Boughton and the writer. The Chinese wood oil was a portion of the original sample used in our committee work last year furnished by Mr. L. P. Nemzek, and known as commercial Chinese wood oil.[1] The raw linseed oil

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 237 (1914). This oil is said by the importers to have been shipped from Hankow.

used was obtained from Mr. Pickard of the American Linseed Co., and was known to be absolutely pure. The soya bean oil was some that I have had in my possession for three years, and represents a sample of a commercial grade known to be pure.

The work on these oils shall consist of making three separate tests.

1. The first test to be made is that reported by Ware and Schumann on page 458, Part II, Vol. XIV of the Proceedings of the Society.

2. The second test to be made is that known as the iodine jelly test. This test was performed last year by the various analysts. The differing results obtained at that time were probably due to certain causes which have been eliminated in a new procedure outlined by Mr. Boughton and attached herewith. Kindly follow this method as carefully as possible. It is expected that both the Ware test and the improved iodine jelly test will give very accurate results.

DIRECTIONS FOR THE IODINE JELLY TEST ON CHINESE WOOD OIL.

In a wide-neck 200-cc. Erlenmeyer flask, place 2.5 g. (weight correct to 1 mg.) of the oil. Add 10 cc. of chloroform from a pipette and stopper the flask immediately. Carefully insert a small glass vial into the flask so that the vial stands upright. Into the vial from a pipette run 10 cc. of a solution of iodine in chloroform, containing 0.035 to 0.036 g. of iodine per cubic centimeter. Place the flask in a bath containing water at 25 to 26° C. and allow it to stand there for a few minutes. Keep the flask stoppered, except when it is necessary to remove it to insert the vial and to add the iodine solution. Tilt and rotate the flask so that the vial is upset and the contents of the flask are thoroughly mixed, at the same time starting a stop watch. Keep the flask in the bath at 25 to 26° C. and at the end of every quarter minute, tilt the flask towards a horizontal position. Note the time required for the formation of a jelly that does not flow, but sticks to the bottom of the flask or slides as a mass. Record time in minutes and quarters thereof. Pure Chinese wood oil should require $2\frac{3}{4}$ to $3\frac{1}{4}$ minutes for the formation of the jelly. If the temperature of the laboratory is more than 2 or 3° C. above or below 25° C., place the flask containing the iodine solution in the bath and allow it to remain there for several minutes before pipetting out the 10 cc. for the test. The arrangement of the apparatus is shown in Fig. 1.

A convenient procedure for preparing the iodine solution is as follows: Treat an excess of iodine with warm chloroform and after shaking for a few minutes, cool the contents to about 20° C. and filter through glass wool. Pipette 10 cc. of the solution into a flask containing 10 cc. of 10-per-cent potassium-iodide solution and titrate with 0.1 normal sodium-thiosulphate solution. Calculate the iodine content and dilute with chloroform so as to obtain an iodine content of 0.035 to 0.036 g. per cubic centimeter. After dilution, titrate again against the thiosulphate to be sure that the solution is of the required strength.

All the details of the above method must be followed exactly.

3. The third test to be performed is that known as the heating test (Browne's method). This test was included in last year's work. You will find the

outline of the test on page 242, Part I, Vol. XIV of the Proceedings of the Society. The variation in the results obtained with this test last year may have been due to the fact that no correction was made for emergent-stem thermometers. Ordinarily, the correction at 290° C. is about 7° C., so that when a temperature of 290° C. is called for, the thermometer should read somewhere around 283° C. In the work this year, it is suggested that you use an immersed-stem thermometer which may be obtained for $1.88 from the C. J. Tagliabue Mfg. Co., 18 Thirty-third Street, Bush Terminal, New York City, as per the following specification:

"Chemical thermometer, engraved stem; total length 4 to 4½ in.; graduated from 210 to 310° C. in intervals of 2° C.; the interval 210 to 310° C. to be not less than 2½ in. long; bulb to be made of good grade thermometer glass; to be well annealed. Thermometer to be nitrogen-filled."

It is hoped that every member of the sub-committee will obtain a thermometer of the above type and use it in the work. If you do not find it convenient to obtain this thermometer, kindly use the ordinary type and make a correction according to the method outlined in Stem Correction Sheet No. 44 of the U. S. Bureau of Standards, entitled "Correction for Emergent Stem."

Kindly send in the report of your analysis of these oils by March 1, 1915, so that they may be arranged for presentation at the next meeting of Committee D-1.

Very truly yours,

H. A. GARDNER,
Chairman of Sub-Committee.

Returns on the above samples were received from seven operators, and the results obtained are shown in Tables I to V.

TABLE I.—SUMMARY OF RESULTS ON SAMPLE NO. 1.

PURE CHINESE WOOD OIL.

Observer.	Ware and Schumann Test, percentage of adulterant.	Iodine Jelly Test, minutes and seconds.	Heating Test (Browne's Method), minutes and seconds.
Gardner and Carmick	2.52	3-00	9-45
Thompson and Mills	....	3-30	11-25
Boughton	3.2	2-30	9-45
Ware	....	2-45	11-0
Bragg and Follin	....	2-30	11-0
Lindsay	....	3-49	12-17
White and Boyle	5.42	....	10-33
Maximum	5.42	3-49	12-17
Minimum	2.52	2-30	9-45
Average	3.71	3-1	10-49

TABLE II.—SUMMARY OF RESULTS ON SAMPLE NO. 2.

CHINESE WOOD OIL, 95 PER CENT; SOYA BEAN OIL, 5 PER CENT.

Observer.	Ware and Schumann Test, percentage of adulterant.	Iodine Jelly Test, minutes and seconds.	Heating Test (Browne's Method), minutes and seconds.
Gardner and Carmick	9.25	3–53	12–45
Thompson and Mills	....	4–32	12–40
Boughton	9.6	3–8	11–0
Ware	....	3–30	12–30
Bragg and Follin	....	3–30	12–0
Lindsay	....	5–32	13–17
White and Boyle	3.35	....	11–9
Maximum	9.6	5–32	13–17
Minimum	3.35	3–8	11–00
Average	7.40	4–1	12–12

TABLE III.—SUMMARY OF RESULTS ON SAMPLE NO. 3.

CHINESE WOOD OIL, 90 PER CENT; SOYA BEAN OIL, 10 PER CENT.

Observer.	Ware and Schumann Test, percentage of adulterant.	Iodine Jelly Test, minutes and seconds.	Heating Test (Browne's Method), minutes and seconds.
Gardner and Carmick	14.17	5–30	14–00
Thompson and Mills	....	6–30	13–50
Boughton	2.3	4–23	11–45
Ware	....	4–30	13–30
Bragg and Follin	....	4–45	13–30
Lindsay	....	6–35	14–31
White and Boyle	7.83	....	12–50
Maximum	14.17	6–35	14–31
Minimum	2.3	4–23	11–45
Average	8.10	5–22	13–25

TABLE IV.—SUMMARY OF RESULTS ON SAMPLE NO. 4.

CHINESE WOOD OIL, 95 PER CENT; LINSEED OIL, 5 PER CENT.

Observer.	Ware and Schumann Test, percentage of adulterant.	Iodine Jelly Test, minutes and seconds.	Heating Test (Browne's Method), minutes and seconds.
Gardner and Carmick	11.17	3–45	12–30
Thompson and Mills	....	4–45	12–45
Boughton	0.9	3–8	12–0
Ware	....	3–30	12–30
Bragg and Follin	....	4–0	12–30
Lindsay	....	4–42	13–53
White and Boyle	4.04	....	11–40
Maximum	11.17	4–45	13–53
Minimum	0.9	3–8	11–40
Average	5.37	3–58	11–7

TABLE V.—SUMMARY OF RESULTS ON SAMPLE NO. 5.

CHINESE WOOD OIL, 90 PER CENT; LINSEED OIL, 10 PER CENT.

Observer.	Ware and Schumann Test, percentage of adulterant.	Iodine Jelly Test, minutes and seconds.	Heating Test (Browne's Method), minutes and seconds.
Gardner and Carmick	13.44	5–15	13–30
Thompson and Mills	....	6–37	13–59
Boughton	....	4–15	13–30
Ware	....	4–30	13–30
Bragg and Follin	....	4–0	14–0
Lindsay	....	6–33	15–17
White and Boyle	7.60	....	14–4
Maximum	13.44	6–37	15–17
Minimum	7.60	4–0	13–30
Average	10.52	5–12	13–59

SUPPLEMENTARY REPORT ON THE EFFECT OF VARIATION OF DIFFERENT FACTORS IN THE IODINE JELLY TEST.

BY E. W. BOUGHTON.

The effect of variation of different factors in the iodine jelly test with pure Chinese wood oil, Sample No. 1, was investigated with the following results:

1. *Effect of Variation in Temperature of Bath.*—Weight of oil = 2.5 g.; 1 cc. iodine solution = 0.035 g. iodine; volume of $CHCl_3$ = 10 cc.

Temperature, deg. Cent.	Time of Test, minutes.
29.5 - 30	$2\frac{1}{2}$
26.8 - 27.3	$2\frac{3}{4}$
25.2 - 25.5	3
23.8 - 24	3

2. *Effect of Variation in Weight of Oil.*—One cubic centimeter iodine solution = 0.035 g. iodine; temperature 25–26° C.; Volume of $CHCl_3$ = 10 cc.

Weight of Oil, g.	Time of Test, minutes.
2.25	$4\frac{1}{4}$
2.50	$2\frac{3}{4}$
2.75	2

3. *Effect of Variation in Amount of Chloroform.*—Weight of oil = 2.5 g.; 1 cc. iodine solution = 0.035 g. iodine; temperature, 25–26° C.

Amount of Chloroform, cc.	Time of Test, minutes.
9.5	$2\frac{3}{4}$
10.0	3
10.5	$3\frac{3}{4}$

4. *Effect of Variation in Strength of Iodine Solution.*—Weight of oil = 2.5 g.; temperature, 25–26° C.; Volume of $CHCl_3$ = 10 cc.

Number of Grams of Iodine in One Cubic Centimeter of Iodine Solution.	Time of Test, minutes.
0.0312	$5\frac{3}{4}$
0.0353	$3\frac{1}{4}$
0.0357	$3\frac{1}{4}$
0.0385	$2\frac{1}{2}$

5. *Tests made According to Adopted Method.*

Oil.	Time of Test, minutes.
Pure Chinese Wood Oil	$3\frac{1}{4}$
	$3\frac{1}{4}$
	$3\frac{1}{4}$
	3
Average	$3\frac{1}{4}$
Chinese Wood Oil plus 5 per cent Linseed Oil	4
	$4\frac{1}{4}$
	$3\frac{3}{4}$
Average	4
Chinese Wood Oil plus 10 per cent Linseed Oil	5
	$5\frac{1}{4}$
	5
Average	5
Chinese Wood Oil plus 5 per cent Cottonseed Oil	$3\frac{3}{4}$
	$3\frac{3}{4}$
	$3\frac{3}{4}$
Average	$3\frac{3}{4}$
Chinese Wood Oil plus 10 per cent Cottonseed Oil	$4\frac{3}{4}$
	$5\frac{1}{4}$
	5
Average	5

The results with pure oil were approximately the same as those obtained with committee oils Nos. 2 and 4, which contained 5 per cent adulteration, but were lower than the results with committee oils Nos. 3 and 5, which contained 10 per cent adulteration.

TESTS ON SPECIAL AMERICAN CHINESE WOOD OILS.

A small quantity of Chinese wood oil was crushed by the U. S. Bureau of Chemistry at Washington from two lots of nuts grown in Florida. Both lots of nuts were procured in Leon County, Fla., and represent the 1914 crop. The following information is submitted by Mr. H. S. Bailey of the Bureau of Chemistry, concerning the expression of the oil:

	LOT NO. 3.	LOT NO. 4.
Average weight of nuts, g	18.4	19.5
Percentage of kernel by weight of nuts	46.0	35.0
Loss of kernel in CO_2 at 100° C., per cent	3.18	2.43
Ash of kernel, per cent	2.50	2.30
Total nitrogen in kernel, per cent	2.60	2.54
Ether extract, per cent	64.18	65.00

The quantity of oil thus obtained was insufficient for distribution to all the members of the sub-committee, and tests were therefore made upon it by only three observers. One sample from each lot was submitted to each of the three observers, labeled as follows:

"Chinese Wood Oil No. 3 (American);" "Chinese Wood Oil No. 4 (American)."

It was thought desirable to make the same tests on these samples as were made upon American grown tung oils last year, namely:

Appearance, Odor, Refractive Index at 25° C., Specific Gravity at 15°.5/15°.5 C., Acid Number, Saponification Number, Iodine Number (Hübl, 18 hours), Iodine Jelly Test (revised), Heating Test, Browne (revised).

The Ware and Schumann Test was optional. With one exception, however, results of only three tests were given, namely, the Ware and Schumann test, the iodine jelly test and the Browne heat test. These results are given in Table VI.

TABLE VI.—SUMMARY OF RESULTS ON CHINESE WOOD OILS (AMERICAN).

Observer.	Ware and Schumann Test, Percentage of Adulterant.		Iodine Jelly Test, minutes and seconds.		Heating Test (Browne's Method), minutes and seconds.		Iodine Number (Hübl, 17 hr.)		Saponification Number.		Acid Number.	
	Oil No. 3.	Oil No. 4.	Oil No. 3.	Oil No. 4.	Oil No. 3.	Oil No. 4.	Oil No. 3.	Oil No. 4.	Oil No. 3.	Oil No. 4.	Oil No. 3.	Oil No. 4
Gardner and Carmick	1.92	2.46	2-45	2-45	10-0	9-30	167.4	168.5	190.0	189.6	0.9	0.6
Nemzek and Reddy.....	....	....	....	....	11-30	11-30	.....	.....	.....	.....	...	...
Boughton	....	....	2-38	2-30	10-30	9-30	.....	.....	.....	.....	...	...
Maximum.....	....	....	2-45	2-45	11-30	11-30	.....	.....	.....	.....	...	...
Minimum.....	....	....	2-38	2-30	10-00	9-30	.....	.....	.....	.....	...	...
Average	....	....	2-42	2-38	10-40	10-10	.....	.....	.....	.....	...	...

COMMENTS ON TESTS.

It is the general opinion of the experimenters that the Ware and Schumann test in its present form is not satisfactory and does not give concordant results. It is thought, however, that by revision and by addition of further details for the washing and drying of the polymerized product, the test might be made of value.

The iodine jelly test was found to give very concordant results by a majority of the members of the sub-committee. It was their experience, however, that it is necessary to have an iodine solution of the exact strength called for. This necessitates that the iodine solution, after preparation, should be carefully titrated with tenth-normal sodium thiosulphate previous to use. If found by titration to be of the exact strength, excellent results may be obtained. By this test the presence of 10 per cent of adulterant in Chinese wood oil is readily detected, while 5 per cent is indicated when the test is carefully made.

The Browne heat test was found to give very accurate results by a majority of the members of the sub-committee, 5 per cent of adulterant lengthening the time of polymerization

very materially. Immersed-stem thermometers, such as specified, may be used, or emergent-stem thermometers will give satisfactory results provided the correction called for is made. One member of the sub-committee has suggested that two minutes previous to polymerization the rod in the oil be lifted at periods of 15 seconds rather than at periods of 30 seconds. Nearly every member of the sub-committee suggested that the test might be improved by having some standard for a heating bath. An insulating jacket would doubtless aid in obtaining a more uniform temperature and thus do away with minor fluctuations which might occur by using the present type of apparatus.

As a result of its work, the sub-committee would recommend the adoption by the Society of the proposed Standard Specifications for Purity of Raw Chinese Wood Oil, appended to this report.[1]

Respectfully submitted on behalf of the sub-committee,

H. A. GARDNER,
Chairman.

[1] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

REPORT OF SUB-COMMITTEE IV ON INSPECTION OF STEEL PLATES AT ATLANTIC CITY.

At a meeting of Committee D-1, held in July, 1914, Sub-Committee IV was directed to prepare a report on the relation of the results obtained on the inspection of the Atlantic City steel panels and the Thompson water test upon which the field tests were based.

It is proper at this time to present a brief résumé of these tests. An extract, therefore, from the report of Committee A-5[1] on the Corrosion of Iron and Steel of 1910 is presented below:

"Three years ago the suggestion was made in a paper presented before the Tenth Annual Meeting of this Society,[2] that the various types of substances used as pigments in protective coatings might exert a stimulative or an inhibitive action on the rate and tendency to corrosion of the underlying metal. It was further suggested on theoretical grounds that slightly soluble chromates should exert a protective action when employed as pigments, by maintaining the surface of the iron in a passive condition in case water and oxygen penetrated the paint film. In view also of the well-known fact that alkalies inhibit while acids stimulate the corrosion of iron, it was suggested that the action of more or less pure pigments on iron in the presence of water should be thoroughly investigated. Two years ago this committee invited the co-operation of Committee D-1 (then known as Committee E) in the investigation, and a special sub-committee representing the two main committees was appointed.

"The methods and results of the water pigment tests have previously been reported and published,[3] and need not be given in detail. Briefly, the method consisted in immersing samples of steel in water suspensions of the various pigments and blowing air through the containers for definite periods of time, the corrosion being measured by the loss in weight sustained by the test pieces. About fifty pigments which are in more or less common use for painting steel were purchased in the open market and distributed among a number of the members of the committee, who agreed to carry out the work. Each investigator worked independently of the others, except that the same general method was followed; the time of exposure to the corroding action,

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. X, p. 73 (1910).

[2] Cushman, "The Corrosion of Iron," *Proceedings*, Am. Soc. Test. Mats., Vol. VII, p. 211 (1907).

[3] Report of Joint Sub-Committee of Committees E and U, Appendix II, *Proceedings*, Am. Soc. Test. Mats., Vol. IX, p. 203 (1909); *Bulletin No. 35*, Office of Public Roads; *Bulletins Nos. 7 and 18*, Scientific Section, Paint Mfrs. Assn.

however, varied in the different experiments. When the results were compared and analyzed by the sub-committee, it was felt that the general agreement of the results obtained by the several investigators was striking and merited further and more systematic work. As a result of these tests the sub-committee tentatively divided the pigments into inhibitors, stimulators, and indeterminates. The word 'indeterminate' was selected after considerable discussion, because the words 'neutral' or 'inert' already possess a special meaning as applied to paint technology. The committee takes this occasion to emphatically state that in adopting this tentative classification, the words 'inhibitive' and 'stimulative' as used by them up to the present time apply only to the results obtained in the water tests, and the inference that the results obtained have decided which class the pigment will fall into when made into a paint with the usual vehicles and used as a protective coating on iron and steel, is not justified. In order to make this point quite clear, it has been agreed by the committee to qualify the classification so as to speak of the various materials tested as 'water stimulative' or 'water inhibitive.'

"As a result of the preliminary tests, it seemed desirable to the committee that a systematic investigation of the same pigments should be made under service conditions. The Paint Manufacturers' Association of the United States offered to erect a series of steel panels at Atlantic City and place them under the supervision and control of this Society. The panels were erected in the autumn of 1908."

The charted results of the Thompson water-pigment tests are shown in the Proceedings of the Society for 1910.[1] The results presented in that table for those pigments adopted for field tests, are shown in more graphic form in Table I of this report. The pigment numbers in Table I are those which were used to designate the pigments in the field tests.

Table II shows the classification of pigments, as determined by the Thompson water tests, this classification having been made by the committee in 1910, after a consideration of the complete data obtained at that time.

In Table III are shown the average ratings of the pigments at each of the five annual inspections. In the column representing the 1914 ratings, blank spaces are shown in several instances. The panels corresponding to these spaces were not included in the 1913–1914 exposure. These panels, having served their usefulness, were removed from the old fence frame during the summer of 1913, the remaining panels being transferred to the frame upon Young's Million Dollar Pier. Although the rejected

[1] Vol. X, p. 76 (1910).

TABLE I.—LOSS OF STEEL, IN GRAMS, IN WATER TESTS ON PIGMENTS TO ASCERTAIN THEIR VALUE AS RUST INHIBITORS.

Pigment No.	Gardner No. 1. 20 Days	Pigment No.	Cushman Nos. 1 & 2. 10 Days	Pigment No.	P. Walker No. 2. 7½ Days	Pigment No.	Cushman No. 2. 10 Days	Pigment No.	W. Walker No. 1.	Pigment No.	Average.
39	0.0050	49	0.0277	40	0.0034	49	0.0085	40	0.0351	39	0.0194
49	0.0094	3	0.0296	39	0.0094	3	0.0085	39	0.0396	40	0.0229
40	0.0153	39	0.0300	48	0.0137	39	0.0130	7	0.0456	49	0.0246
6	0.0160	40	0.0468	49	0.0153	40	0.0140	48	0.0496	3	0.0682
48	0.0247	7	0.1712	45	0.0448	7	0.0856	3	0.0504	7	0.0876
7	0.0842	31	0.2143	7	0.0515	45	0.1130	49	0.0620	48	0.1186
41	0.0860	45	0.2267	41	0.0548	1	0.1150	29	0.1208	41	0.1453
45	0.1438	41	0.2269	4	0.0982	41	0.1240	14	0.1564	45	0.1591
3	0.1524	15	0.2620	5	0.1001	20	0.1362	15	0.1914	6	0.1754
20	0.1694	20	0.2795	3	0.1002	15	0.1408	20	0.2110	20	0.1880
1	0.2040	1	0.2895	32	0.1248	31	0.1597	31	0.2174	1	0.2122
2	0.2120	48	0.3185	6	0.1274	36	0.1763	2	0.2274	2	0.2176
33	0.2394	2	0.3352	2	0.1288	6	0.1792	36	0.2288	31	0.2328
14	0.2682	5	0.3425	36	0.1319	2	0.1848	9	0.2315	15	0.2352
5	0.3177	29	0.3620	29	0.1384	48	0.1865	41	0.2346	29	0.2484
32	0.3493	36	0.3767	20	0.1439	34	0.1877	30	0.2616	5	0.2492
30	0.3574	6	0.3791	9	0.1719	9	0.2065	45	0.2671	36	0.2645
15	0.3774	33	0.4025	33	0.1748	44	0.2195	1	0.2743	14	0.2666
29	0.3828	34	0.4147	31	0.1759	33	0.2240	4	0.3116	33	0.2762
12	0.3878	9	0.4336	1	0.1781	5	0.2365	32	0.3212	9	0.2970
31	0.3966	44	0.4559	30	0.1828	4	0.2372	34	0.3387	32	0.3034
24	0.4027	14	0.4756	14	0.1955	14	0.2375			30	0.3111
36	0.4090	32	0.4770	15	0.1983	29	0.2380			34	0.3270
4	0.4176	30	0.4910	44	0.2055	32	0.2445			4	0.3300
34	0.4328	16	0.5437	24	0.2119	30	0.2625	33	0.3405	44	0.3825
16	0.4342	4	0.5856	27	0.2547	17	0.2789	12	0.4429	27	0.4472
9	0.4416	27	0.5883	16	0.2606	16	0.3173	28	0.5064	16	0.4545
27	0.4454	17	0.6337	34	0.2612	12	0.3707	17	0.5095	12	0.4566
21	0.5003	21	0.6955	19	0.2838	21	0.3751	44	0.5202	17	0.4641
44	0.5113	12	0.7896	12	0.2920	27	0.3841	27	0.5636	24	0.4716
28	0.5247	24	0.8408	28	0.3132	24	0.4315	21	0.5716	21	0.5099
17	0.5262	28	0.8806	17	0.3723	28	0.5085	19	0.6257	28	0.5467
19	0.7180	19	1.3098	21	0.4069	19	0.7069	16	0.7165	19	0.7294

Inhibitive. — These Pigments were Termed Water Inhibitive because of the Small Loss of Weight Shown by Test Pieces.
Indeterminate. — " " " " " Indeterminate " " " Medium " " " " " "
Stimulative. — " " " " " Stimulative " " " Large " " " " " "

panels had an average rating of over 1, they were considered as having zero ratings when striking the averages for the 1914 report.

The average ratings are presented in Table IV for each class of pigment for each year. In the preparation of Table IV, all the pigments were grouped together according to the class in which they were originally placed in the Thompson water tests. The average ratings were added together and the sum divided by the number of pigments included.

TABLE II.—CLASSIFICATION OF PIGMENTS BASED ON RESULTS OF THOMPSON WATER TESTS.

Water-Inhibitive Pigments.	Water-Indeterminate Pigments.	Water-Stimulative Pigments.
Zinc-and-Lead Chromate	White Lead (quick process, Basic Carbonate)	Lampblack
Zinc Oxide	Sublimed White Lead (Basic Sulfate)	Barium Sulfate (precipitated)
Zinc Chromate	Sublimed Blue Lead	Ochre
Zin -and-Barium Chromate	Lithopone	Bright Red Oxide
Zinc Lead White	Orange Mineral (American)	Carbon Black
Prussian Blue (inhibitive)	Red Lead	Graphite (artificial)
Chrome Green	Venetian Red	Barium Sulfate (barytes)
White Lead (Dutch Process)	Prince's Metallic Brown	Graphite (natural)
Ultramarine Blue	Calcium Carbonate (whiting)	Prussian Blue (stimulative)
Willow Charcoal	Calcium Carbonate (precipitated)	
	Calcium Sulfate	
	China Clay	
	Asbestine	
	American Vermilion[1]	
	Medium Chrome Yellow	

[1] When the name American Vermilion occurs it refers to basic lead chromate.

In Table V the pigments have been graded into classes on the basis of the average ratings given in Table III; while in Table VI have been listed the pigments of the ten highest and ten lowest ratings for each year.

There is also shown in Table VII a list of the sixteen pigments which received the ten lowest ratings for 1914, taking into consideration all those pigments which were not exposed during 1914 and which in the calculation of the averages shown

TABLE III.—AVERAGE RATINGS OF PIGMENTS.

No.	Pigment	Classification in Water Tests.	Average Rating of Oil Tests.				
			1910.	1911.	1912.	1913.	1914.
1	Dutch-process white lead	Inhibitive	8.7	3.7	1.9	1.3	...[a]
2	Quick-process white lead	Indeterminate	8.9	4.2	2.1	1.3	...[a]
3	Zinc oxide	Inhibitive	3.0	1.5	0.7	0.8	...[a]
4	Sublimed white lead	Indeterminate	9.5	9.0	8.1	5.9	3.5
5	Sublimed blue lead	Indeterminate	9.6	8.8	9.0	7.2	6.0
6	Lithopone	Indeterminate	4.1	2.2	0.8	0.4	...[a]
7	Zinc lead	Inhibitive	8.0	4.7	4.5	3.3	...[a]
9	Orange mineral	Indeterminate	9.0	8.3	6.9	4.0	3.0
10	Red lead	Indeterminate	8.7	8.3	8.1	6.3	4.0
12	Bright red oxide	Stimulative	9.3	8.1	6.7	4.5	2.5
14	Venetian red	Indeterminate	7.2	8.0	6.4	5.1	1.5
15	Metallic brown	Indeterminate	6.3	6.3	6.2	6.1	3.0
16	Natural graphite	Stimulative	9.1	6.8	6.6	6.2	4.0
17	Artificial graphite	Stimulative	7.1	5.9	4.4	2.6	0.0
19	Lampblack	Stimulative	7.1	6.3	5.5	4.2	0.0
20	Willow charcoal	Inhibitive	8.8	8.8	8.6	7.9	4.5
21	Carbon black	Stimulative	8.3	7.2	7.0	6.8	5.0
24	Yellow ochre	Stimulative	5.8	5.5	5.8	5.2	1.5
27	Barytes (natural)	Stimulative	4.4	0.7	0.3	0.1	...[a]
28	[1]Barytes (precipitated)	Stimulative	4.1	1.8	0.7	0.2	...[a]
29	Calcium carbonate (whiting)	Indeterminate	0.1	0.0	0.0	0.0	...[a]
30	Clacium carbonate (precipitated)	Indeterminate	0.0	0.0	0.0	0.0	...[a]
31	Calcium sulfate (gypsum)	Indeterminate	2.5	1.7	0.9	0.2	...[a]
32	China clay	Indeterminate	7.3	6.3	2.7	1.3	...[a]
33	Asbestine	Indeterminate	7.3	5.1	1.9	1.2	...[a]
34	American vermilion	Indeterminate	9.1	10.0	9.9	9.8	7.5
36	Medium chrome yellow	Indeterminate	7.0	7.7	6.0	5.2	3.5
39	Zinc chromate	Inhibitive	9.4	9.5	8.8	8.0	4.0
40	Zinc-and-barium chromate	Inhibitive	9.7	9.5	8.5	7.8	2.5
41	Chrome green	Inhibitive	9.8	9.8	8.6	7.6	5.0
44	Prussian blue (water stimulative)	Stimulative	9.2	9.0	7.8	6.7	3.5
45	Prussian blue (water inhibitive)	Inhibitive	8.8	8.5	7.2	5.0	...[a]
48	Ultramarine blue	Inhibitive	4.0	0.0	0.0	0.0	...[a]
49	Zinc-and-lead chromate	Inhibitive	9.5	9.7	9.2	8.3	4.0
51	[2]Magnetic black oxide	Unclassified	9.5	9.5	8.6	7.8	4.0

[a] Panels removed from fence in 1913.

[1] Pigment No. 28 originally classified in Thompson water test as Stimulative. Reported in error as Indeterminate in table on p. 370, Vol. XIII, Proceedings 1913.

[2] This pigment was not included in the original water tests, and its classification is not given or taken into consideration in the averages. It was included in the field tests at the suggestion of S. S. Voorhees. It proved in later individual tests to be water inhibitive.

TABLE IV.—AVERAGE RATING OF EACH CLASS OF PIGMENTS.

Pigments.	Average Rating in				
	1910.	1911.	1912.	913.	1914.
Inhibitive	8.0	6.6	5.8	5.0	2.0
Indeterminate	6.4	5.7	4.6	3.6	2.1
Stimulative	7.2	5.7	5.0	4.1	1.8

in Table IV were given the arbitrary rating of zero. The 1913 ratings for these sixteen pigments are also shown.

Although fully recorded in previous reports,[1] it is thought advisable to state herein that a few of the paints applied to the steel panels required special preparation. Because of the nature of the pigments used in these paints, the adoption of the volume formula necessitated the addition in two instances (pigments Nos. 19[2] and 21[3]) of definite volume quantities of another heavier

TABLE V.—GRADING OF PIGMENTS AT ANNUAL INSPECTION.

Year.	Classification.	Failed.		Poor.		Fair.		Good.		Excellent.		Totals.	
		Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
1910	Inhibitive	0	0.0	2	20.0	0	0.0	1	10.0	7	70.0	10	100.0
	Indeterminate	2	13.3	1	6.7	1	6.7	5	33.3	6	40.0	15	100.0
	Stimulative	0	0.0	0	0.0	3	33.3	2	22.2	4	44.5	9	100.0
1911	Inhibitive	2	20.0	1	10.0	1	10.0	0	0.0	6	60.0	10	100.0
	Indeterminate	3	20.0	1	6.7	2	13.3	4	26.7	5	33.3	15	100.0
	Stimulative	2	22.2	0	0.0	2	22.2	3	33.4	2	22.2	9	100.0
1912	Inhibitive	3	30.0	0	0.0	1	10.0	1	10.0	5	50.0	10	100.0
	Indeterminate	5	33.3	2	13.3	0	0.0	4	26.7	4	26.7	15	100.0
	Stimulative	2	22.2	0	0.0	3	33.3	4	44.5	0	0.0	9	100.0
1913	Inhibitive	3	30.0	1	10.0	1	10.0	4	40.0	1	10.0	10	100.0
	Indeterminate	7	46.6	1	6.7	3	20.0	3	20.0	1	6.7	15	100.0
	Stimulative	2	22.2	1	11.1	3	33.3	3	33.4	0	0.0	9	100.0
1914	Inhibitive	5	50.0	3	30.0	2	20.0	0	0.0	0	0.0	10	100.0
	Indeterminate	8	53.3	5	33.3	1	6.7	1	6.7	0	0.0	15	100.0
	Stimulative	5	55.6	3	33.3	1	11.1	0	0.0	0	0.0	9	100.0

NOTE.—The schedule of marking was as follows: Excellent, 10 to 8; good, 8 to 6; fair, 6 to 4; poor, 4 to 2; failed, 2 to 0.

and coarser pigment, in order to make the paints of sufficient body for application. In five instances (pigments Nos. 3, 12, 21, 36 and 45)[4] the paints thus made were extremely heavy and required slight reduction with turpentine. These facts should

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. X, p. 79 (1910).

[2] Contained 17 per cent lampblack and 83 per cent barytes.

[3] Contained 12 per cent carbon black and 88 per cent barytes.

[4] One thousand grams of pigment required turpentine to the amount as follows:

Zinc Oxide, No. 3	170 g.
Bright Red Oxide, No. 12	166 g.
Carbon Black and Barytes, No. 21	218 g.
Medium Chrome Yellow, No. 36	299 g.
Prussian Blue, No. 45	163 g.

TABLE VI.—PIGMENTS OF TEN HIGHEST AND TEN LOWEST RATINGS AT ANNUAL INSPECTION.

1910

TEN HIGHEST RATINGS.

Pigment.	Classification.	Rating.
Chrome green	Inhibitive	9.8
Zinc-and-barium chromate	Inhibitive	9.7
Sublimed blue lead	Indeterminate	9.6
Sublimed white lead	Indeterminate	9.5
Zinc-and-lead chromate	Inhibitive	9.5
Magnetic black oxide	Unclassified	9.5
Zinc chromate	Inhibitive	9.4
Bright red oxide	Stimulative	9.3
Prussian blue (water stimulative)	Stimulative	9.2
American vermilion	Indeterminate	9.1

4, Inhibitive; 3, Indeterminate; 2, Stimulative; 1, Unclassified.

TEN LOWEST RATINGS.

Calcium carbonate (precipitated)	Indeterminate	0.0
Calcium carbonate (whiting)	Indeterminate	0.1
Calcium sulfate (gypsum)	Indeterminate	2.5
Zinc oxide	Inhibitive	3.0
Ultramarine blue	Inhibitive	4.0
Lithopone	Indeterminate	4.1
Barytes (precipitated)	Stimulative	4.1
Barytes (natural)	Stimulative	4.4
Yellow ochre	Stimulative	5.8
Metallic brown	Indeterminate	6.3

2, Inhibitive; 5, Indeterminate; 3, Stimulative.

1911

TEN HIGHEST RATINGS.

Pigment.	Classification.	Rating.
American vermilion	Indeterminate	10.0
Chrome green	Inhibitive	9.8
Zinc-and-lead chromate	Inhibitive	9.7
Zinc chromate	Inhibitive	9.5
Zinc-and-barium chromate	Inhibitive	9.5
Magnetic black oxide	Unclassified	9.5
Sublimed white lead	Indeterminate	9.0
Sublimed blue lead	Indeterminate	8.8
Willow charcoal	Inhibitive	8.8
Prussian blue (water inhibitive)	Inhibitive	8.5

6, Inhibitive; 3, Indeterminate; 1, Unclassified.

TEN LOWEST RATINGS.

Ultramarine blue	Inhibitive	0.0
Calcium carbonate (whiting)	Indeterminate	0.0
Calcium carbonate (precipitated)	Indeterminate	0.0
Barytes (natural)	Stimulative	0.7
Zinc oxide	Inhibitive	1.5
Calcium sulfate (gypsum)	Indeterminate	1.7
Barytes (precipitated)	Stimulative	1.8
Lithopone	Indeterminate	2.2
Dutch-process white lead	Inhibitive	3.7
Quick-process white lead	Indeterminate	4.2

3 Inhibitive; 5, Indeterminate; 2, Stimulative.

TABLE VI.—*Continued.*

1912

TEN HIGHEST RATINGS.

Pigment.	Classification.	Rating.
American vermilion	Indeterminate	9.9
Zinc-and-lead chromate	Inhibitive	9.2
Sublimed blue lead	Indeterminate	9.0
Zinc chromate	Inhibitive	8.8
Willow charcoal	Inhibitive	8.6
Chrome green	Inhibitive	8.6
Magnetic black oxide	Unclassified	8.6
Zinc-and-barium chromate	Inhibitive	8.5
Sublimed white lead	Indeterminate	8.1
Red lead	Indeterminate	8.1

5, Inhibitive; 4, Indeterminate; 1, Unclassified.

TEN LOWEST RATINGS.

Ultramarine blue	Inhibitive	0.0
Calcium carbonate (whiting)	Indeterminate	0.0
Calcium carbonate (precipitated)	Indeterminate	0.0
Barytes (natural)	Stimulative	0.3
Barytes (precipitated)	Stimulative	0.7
Zinc oxide	Inhibitive	0.7
Lithopone	Indeterminate	0.8
Calcium sulfate (gypsum)	Indeterminate	0.9
Dutch process white lead	Inhibitive	1.9
Asbestine	Indeterminate	1.9

3, Inhibitive; 5, Indeterminate; 2, Stimulative.

1913

TEN HIGHEST RATINGS.

Pigment.	Classification.	Rating.
American vermilion	Indeterminate	9.8
Zinc-and-lead chromate	Inhibitive	8.3
Zinc chromate	Inhibitive	8.0
Willow charcoal	Inhibitive	7.9
Zinc-and-barium chromate	Inhibitive	7.8
Magnetic black oxide	Unclassified	7.8
Chrome green	Inhibitive	7.6
Sublimed blue lead	Indeterminate	7.2
Carbon black	Stimulative	6.8
Prussian blue (water stimulative)	Stimulative	6.7

5, Inhibitive; 2, Indeterminate; 2, Stimulative; 1, Unclassified.

TEN LOWEST RATINGS.[1]

Ultramarine blue	Inhibitive	0.0
Calcium carbonate (whiting)	Indeterminate	0.0
Calcium carbonate (precipitated)	Indeterminate	0.0
Barytes (natural)	Stimulative	0.1
Barytes (precipitated)	Stimulative	0.2
Calcium sulfate (gypsum)	Indeterminate	0.2
Lithopone	Indeterminate	0.4
Zinc oxide	Inhibitive	0.8
Asbestine	Indeterminate	1.2
China clay	Indeterminate	1.3
Dutch-process white lead	Inhibitive	1.3
Quick-process white lead	Indeterminate	1.3

3, Inhibitive; 7, Indeterminate; 2, Stimulative.

[1] Where more than one pigment received the same rating, the extra pigments were included in the table.

TABLE VI.—*Continued.*

1914

TEN HIGHEST RATINGS FOR PIGMENTS EXPOSED AND INSPECTED IN 1914.

Pigment.	Classification.	Rating.
American vermilion	Indeterminate	7.5
Sublimed blue lead	Indeterminate	6.0
Carbon black	Stimulative	5.0
Chrome green	Inhibitive	5.0
Willow charcoal	Inhibitive	4.5
Red lead	Indeterminate	4.0
Natural graphite	Stimulative	4.0
Zinc chromate	Inhibitive	4.0
Zinc-and-lead chromate	Inhibitive	4.0
Magnetic black oxide	Unclassified	4.0

4, Inhibitive; 3, Intermediate; 2, Stimulative; 1, Unclassified.

TEN LOWEST RATINGS FOR PIGMENTS EXPOSED AND INSPECTED IN 1914

Artificial graphite	Stimulative	0.0
Lampblack	Stimulative	0.0
Venetian red	Indeterminate	1.5
Yellow ochre	Stimulative	1.5
Bright red oxide	Stimulative	2.5
Zinc-and-barium chromate	Inhibitive	2.5
Metallic brown	Indeterminate	3.0
Orange mineral	Indeterminate	3.0
Sublimed white lead	Indeterminate	3.5
Medium chrome yellow	Indeterminate	3.5
Prussian blue (water stimulative)	Stimulative	3.5

1, Inhibitive; 5, Indeterminate; 5, Stimulative.

be considered in judging the report of the results on these seven tests.

The summarized results indicate that the water test as at present developed cannot be depended upon to give accurate information as to the protection which pigments will or will not afford metal structures when such pigments are applied in oil media. The summarized results also indicate that the arbitrary designations, inhibitive, indeterminate, and stimulative, as referring to the results of the water test are not always applicable to the same pigments when used with linseed oil for protective coatings. The actual exposure tests of the oil paints have afforded considerable information regarding the protective value of pigments, many of which have not been used heretofore in paints for the protection of metal surfaces.

The sub-committee would recommend that a further study be made of paint materials for metal surfaces. It is believed that there are factors in the water test which, if properly developed,

TABLE VII.—SIXTEEN LOWEST RATINGS AT 1914 INSPECTION (INCLUDING DISCARDED PANELS, WHICH WERE ARBITRARILY RATED AT ZERO).

Panel No.	Pigment.	Classification.	1913 Rating.	1914 Arbitrary Rating.
1	Dutch-Process White Lead	Inhibitive	1.3	0.0
2	Quick-Process White Lead	Indeterminate	1.3	0.0
3	Zinc Oxide	Inhibitive	0.8	0.0
6	Lithopone	Indeterminate	0.4	0.0
7	Zinc Lead	Inhibitive	3.3	0.0
17	Artificial Graphite	Stimulative	2.6	0.0[a]
19	Lampblack	Stimulative	4.2	0.0[a]
27	Barytes (natural)	Stimulative	0.1	0.0
28	Barytes (precipitated)	Stimulative	0.2	0.0
29	Calcium carbonate (whiting)	Indeterminate	0.0	0.0
30	Calcium carbonate (precipitated)	Indeterminate	0.0	0.0
31	Calcium sulfate (gypsum)	Indeterminate	0.2	0.0
32	China clay	Indeterminate	1.3	0.0
33	Asbestine	Indeterminate	1.2	0.0
45	Prussian blue (water inhibitive)	Inhibitive	5.0	0.0
48	Ultramarine blue	Inhibitive	0.0	0.0

[a] Actual average ratings of 1914 inspection.

are capable of giving useful information, and it is therefore recommended that the water test for pigments in some possible modification be further investigated.

The sub-committee having served its usefulness as outlined, respectfully requests that it be discharged.

Respectfully submitted on behalf of the sub-committee,

H. A. GARDNER,
Chairman.

REPORT OF SUB-COMMITTEE V ON LINSEED OIL.

Sub-committee V sent to the several analysts reporting, portions of the four original samples of raw linseed oil secured in 1909, two new samples of raw oil, and four new samples of boiled linseed oil.

The history of the new samples is as follows:

No. 30, raw linseed oil. Sample taken at the Minneapolis plant of the Midland Linseed Products Co., December 19, 1913, by Messrs. Smith, Parkin and Haynes of the St. Paul Food and Drug Inspection Laboratory of the Bureau of Chemistry. The sample is of old process expressed oil from 1913 crop, North American Seed. Information given by F. J. Bisbee, Superintendent. Bottled January 22, 1914, by G. H. Pickard.

No. 31, raw linseed oil. Sample taken at the Wright and Hill plant of the American Linseed Co. in Chicago on December 8, 1913, by C. B. Gnadinger of the Chicago Food and Drug Inspection Laboratory, Bureau of Chemistry. The sample is of old process expressed oil from 1913 crop, North American Seed. Information furnished by T. C. Andrews, Manager. Bottled January 22, 1914, by G. H. Packard.

No. 32, boiled linseed oil. Sample taken at the Minneapolis plant of the Midland Linseed Products Co., December 19, 1913, by Messrs. Smith, Parkin and Haynes of the St. Paul Food and Drug Inspection Laboratory, Bureau of Chemistry. The sample is of old process expressed oil from 1913 crop, North American Seed, and was prepared by use of a linoleate drier. Information furnished by F. J. Bisbee, Superintendent. Bottled January 22, 1914, by G. H. Pickard.

No. 33, boiled linseed oil. Sample taken at the Atlantic branch of the National Lead Co. in Brooklyn, New York, on January 9, 1914, by E. F. Higgins of the New York Food and Drug Inspection Laboratory, Bureau of Chemistry. The sample is of old process expressed oil from 1913 crop, North American Seed. It was prepared by use of a linoleate drier. The raw oil was heated about 15 hours at 350° F. with drier present. Information furnished by W. H. Muesch, General Foreman. Bottled January 22, 1914, by G. H. Pickard.

No. 34, boiled linseed oil. Sample taken at the Minneapolis plant of the Archer-Daniels Linseed Co., December 19, 1913, by Messrs. Smith, Parkin and Haynes of the St. Paul Food and Drug Inspection Laboratory, Bureau of Chemistry. The sample is of old process expressed oil from 1913 crop, North American Seed. It was prepared with commercial drier made by the Tower Varnish Co. and contained no resinate. Information given by H. G. Mixer, Superintendent. Bottled January 22, 1914, by G. H. Pickard.

No. 35, boiled linseed oil. Sample taken at the Wright and Hill plant of the American Linseed Co. in Chicago, December 8, 1913, by C. B Gnadinger of the Chicago Food and Drug Inspection Laboratory, Bureau of Chemistry. The sample is of old process expressed oil from 1913 crop, North American Seed. It was prepared by use of resinate drier. Information furnished by T. C. Andrews, Manager. Bottled January 22, 1914, by G. H. Pickard.

The analysts whose results are given herewith are:

No. 1, G. W. Thompson, Chief Chemist, National Lead Co., 129 York St., Brooklyn. Work done by C. B. Mills.

No. 2, G. H. Pickard, Chemist, American Linseed Co., South Chicago, Illinois. Work done by H. A. Crown.

No. 3, E. W. Martin, Chemist, Midland Linseed Products Co., Minneapolis, Minn.

No. 4, P. H. Walker, Chemist, Bureau of Standards, Washington, D. C. Work done by G. J. Hough.

No. 5, E. W. Boughton, Associate Chemist, Bureau of Standards, Washington, D. C.

No. 6, S. S. Voorhees, Chemist, Bureau of Standards, Washington, D. C. Work done by F. A. Wertz.

No. 7, D. A. Kohr, Superintendent, The Lowe Brothers Co., Dayton, Ohio. Work done by H. G. Mougey.

The following outline of work was sent to the above analysts:

Six samples are of raw oil, Nos. 1, 2, 3 and 4, the history of which is given in the reports of Committee D-1, and Nos. 30 and 31, which are oils produced by hydraulic pressure from 1913 crop of flaxseed. On these samples determine: the hexabromides by the Eibner method outlined on pages 393 to 398, Volume XIII of the Proceedings of the Society; the specification constants by the methods given in the Standard Specifications for the Purity of Raw Linseed Oil from North American Seed; and the iodine number on the fatty acids. The acids resulting from the Eibner process may be used. To fix limits for the iodine number of the fatty acids of linseed oil is important because it has been found that if the oil from a paste lead is saponified, for instance, and the acids are obtained, they show a normal iodine number while the same determination on the extracted oil itself gives no conclusive evidence of its purity.

Owing to the fact that the Boemer method for the determination of the unsaponifiable matter of linseed oil is cumbersome and expensive, the subcommittee decided to ask that work be done to devise an alternate for it. The extraction of the dry soap offers a promising field, so we ask that you use one of the methods outlined by authorities for the determination of unsaponifiable matter by extraction of the dried soap, modify it, if you deem it advisable, reporting with your results a detailed outline of the method employed.

BOILED OILS.

The sub-committee hopes that the results of the work on boiled oils here given will enable us to draw up specifications for this commodity. Our report last year showed on a number of samples of boiled oil that several methods for the determination of the ash and the constituents of it gave concordant results. We are sending out more samples this year, Nos. 32, 33 and 34 of the linoleate type, and 35 of the resinate type. On these samples determine the specification constants, the ash, the percentage of lead, manganese and calcium by any of the methods of the 1913 report of the sub-committee, and the unsaponifiable matter by the method you use on the raw oil.

We give herewith a modification of the Twitchell method prepared by G. W. Thompson for the determination of resin acids in linseed oil.

GENERAL OUTLINE OF METHOD FOR ROSIN IN BOILED OIL.

A quantity of oil is weighed into a separatory funnel and thinned with ether. The bases are separated by treating the oil in ether with HCl (1 : 1). To the washed solution remaining in funnel, alcohol is added and a definite excess of alkali; water is added and all of the rosin and a small amount of oil and its acids shaken out. The soap solution is drawn off and the fatty and resin acids separated and washed in the usual manner. Finally the combined acids are dissolved in alcohol and the Twitchell method followed out in detail, determining the resin, volumetrically.

The method is carried out as follows:

Twenty-five grams of oil are thinned with 75 cc. of ether, 50 cc. of HCl (1 : 1) added, and the mixture thoroughly shaken, allowed to separate and the acid layer drawn off; the oily layer then washed twice with water, using a salt solution to break up any emulsion formed. To the washed ether layer 25 cc. of alcohol are added and a few drops of phenolpthalein. Now, a normal solution of KOH is run in until, after thorough shaking, a permanent pink color is obtained; 100 cc. of water are then added and 5 cc. more of the normal alkali. The excess is kept constant. The whole is agitated for a couple of minutes, then allowed to settle out; the soap solution is drawn off and the oily layer again treated with 25 cc. of alcohol, 50 cc. of water, and 1 cc. of normal KOH. This is shaken and allowed to separate, the second soap solution drawn off, and the oil layer washed three times with water and alcohol (1 : 1).

This treatment will remove all the rosin and a small amount of fatty acids. The soap solution is evaporated on the steam bath, dissolved in water and made acid; the fatty and rosin acids are separated as usual, dissolved in ether and thoroughly washed with water. The solution of fatty and rosin acids is filtered into a flask and the ether distilled off; the dry fatty and rosin acids are dissolved in absolute alcohol and then treated by the Twitchell method for rosin.

In working this method on samples of known rosin contents, the following results were found:

	ROSIN IN OIL, PER CENT.	ROSIN FOUND BY FOREGOING METHOD, PER CENT.
Sample No. 1	0.5	0.64
Sample No. 2	1.0	1.17
Sample No. 3	3.0	3.04
Sample No. 4	5.0	4.90

It was necessary to make a slight correction for acidity in a pure oil run through by this method. Further work may show a way to make this allowance unnecessary.

Correction in this set of samples, 0.59 per cent.

Apply this method to the boiled oils. If any modification of the method as outlined occurs to you, report it with your results.

Tables I and II give the constants of raw and boiled linseed oil, respectively, as reported by the various analysts.

A study of these figures furnishes much interesting and valuable material. Storing raw linseed oil in sealed containers for a period of five years has made no appreciable change in any of the original figures save that of the acid number, which is higher. Oil from 1913 crop North American seed possesses constants practically the same as oil from other crops which the committee has reported. This shows uniformity of oil produced year by year in the same locality.

The iodine number of the fresh fatty acids from a linseed oil averages on the six raw oils 3.1 per cent higher than the same figure on the oil. The greatest difference is 3.73 per cent, while the lowest is 2.13 per cent. It is valuable to know the limits for the iodine number on the fatty acids because often the oil, if extracted from paints, has been so affected by the treatment accorded it that its iodine number is no proof of its purity; while if the acids from this same oil can be obtained, they will give normal figures. This is true, for instance, of oils extracted from paste or liquid paints. The data acquired by the committee thus far do not, in its judgment, warrant the placing of limits for the iodine value of the free fatty acids, but valuable information has been secured.

Table III gives the average values of all determinations of the percentage of unsaponifiable matter.

TABLE I.—RAW LINSEED OIL.

Analyst No.	Specific Gravity at 15°.5/15°.5C.	Iodine Number of		Hexabromides of Fatty Acids, per cent.	Saponification Number.	Acid Number.	Refractive Index at 25° C.	Unsaponifiable Matter, per cent.	
		Oil.	Fatty Acids.					Method No. 1.[a]	Method No. 2.[b]
Sample No. 1.									
1	0.9340	186.1	192.1	51.89	190.6	1.72	1.4806	1.09	1.07
2	0.9351	187.5	193.4	51.99	190.5	1.50	.....	....	0.95
3	0.9349	187.9	.....	.....	194.9	1.63	1.4802	....	....
4	0.9356	187.5	.....	.....	195.3	1.54	.....	1.01	0.88
5	0.9346	188.7	.....	.....	191.4	1.59	1.4817	1.26	....
6	0.9343	189.0	.....	.....	190.2	1.52	1.4804	....	....
7	0.9350	190.9	.....	.....	190.1	1.80	.....	....	....
Aver..	0.9348	188.2	192.7	51.94	191.8	1.61	1.4807	1.12	0.96
Sample No. 2.									
1	0.9328	182.7	188.3	49.49	191.9	5.09	1.4791	1 11	1.05
2	0.9333	185.9	192.0	49.39	192.0	4.81	.....	....	0.91
3	0.9332	185.2	.....	.....	193.7	5.16	1.4795	....	....
4	0.9338	184.0	.....	.....	193.5	5.16	.....	0.99	0.83
5	0.9330	185.5	.....	.....	191.3	5.08	1.4806	1.29	....
6	0.9325	186.4	.....	.....	190.0	5.09	1.4798	....	....
7	0.9356	186.9	.....	.....	190.4	5.30	.....	....	....
Aver..	0.9334	185.2	190.1	49.44	191.8	5.09	1.4797	1.13	0.93
Sample No. 3.									
1	0.9331	185.0	190.3	51.54	190.6	3.62	1.4792	1.09	1.17
2	0.9333	187.3	190.0	51.87	193.6	3.41	.....	....	1.14
3	0.9332	187.8	.....	.....	194.2	3.70	1.4797	....	....
4	0.9340	185.2	.....	.....	193.3	3.68	.....	0.92	0.68
5	0.9332	188.6	.....	.....	190.7	3.66	1.4812	1.12	....
6	0.9326	188.9	.....	.....	189.6	3.56	1.4799	....	....
7	0.9346	189.1	.....	.....	191.5	3.91	.....	....	....
Aver..	0.9334	187.4	190.1	51.70	191.9	3.64	1.4801	1.04	0.99
Sample No. 4.									
1	0.9341	184.5	190.0	50.78	191.2	2.19	1.4794	1.19	1.20
2	0.9342	185.6	192.4	50.95	190.2	2.03	.....	....	1.03
3	0.9343	186.0	.....	.....	194.1	2.08	1.4798	....	....
4	0.9350	185.2	.....	.....	194.0	2.20	.....	1.10	0.75
5	0.9343	185.8	.....	.....	191.3	2.00	1.4807	1.37	....
6	0.9337	186.6	.....	.....	190.0	1.96	1.4801	....	....
7	0.9363	188.4	.....	.....	189.9	2.26	.....	....	....
Aver..	0.9345	186.0	191.0	50.86	191.5	2.10	1.4800	1.22	1.39
Sample No. 30.									
1	0.9339	179.3	186.8	48.58	190.9	2.06	1.4796	1.02	1.01
2	0.9341	181.9	189.3	47.57	189.2	1.79	.....	....	1.15
3	0.9335	181.9	.....	.....	195.1	2.07	1.4794	....	....
4	0.9346	180.2	.....	.....	192.7	1.99	.....	1.04	0.98
5	0.9341	182.5	.....	.....	192.4	2.65	1.4810	1.25	....
6	0.9333	182.5	.....	.....	190.0	1.91	1.4796	....	....
7	0.9355	183.8	189.2	.....	192.0	2.18	.....	....	....
Aver..	0.9341	181.7	188.4	48.07	191.7	2.09	1.4799	1.10	1.04
Sample No. 31.									
1	0.9366	183.5	189.9	48.83	191.6	1.54	1.4799	1.08	1.02
2	0.9343	184.8	191.9	49.43	191.4	1.49	.....	....	1.13
3	0.9347	183.8	.....	.....	194.6	1.54	1.4796	....	....
4	0.9347	183.5	.....	.....	193.5	1.66	.....	0.98	0.95
5	0.9340	184.0	.....	.....	190.8	2.17	1.4815	1.20	....
6	0.9333	186.0	.....	.....	189.8	1.45	1.4799	....	....
7	0.9343	186.7	.....	.....	190.2	1.81	.....	....	....
Aver..	0.9341	184.7	190.9	49.13	191.7	1.66	1.4802	1.08	1.03

[a] Boemer method, using ether.
[b] Extraction of dry soap, using petrolic ether.

TABLE II.—BOILED LINSEED OIL.

Analyst No.	Specific Gravity at 15°.5/15°.5 C.	Iodine Number.	Saponification Number.	Acid Number.	Refractive Index at 25° C.	Percentage of					Unsaponifiable Matter, per cent.		
						Hexabromides of Fatty Acids.	Ash.	Lead.	Manganese.	Calcium.	Method No. 1.[a]	Method No. 2.[b]	Method No. 3.[c]
SAMPLE No. 32.													
1	0.9359	177.7	190.9	3.41	1.4808	47.71	0.347	0.066	0.081	0.024	1.19	0.99	0.72
2	0.9365	180.3	189.7	3.32	.....	47.25	0.353	0.082	0.079	0.029	....	1.17	....
3	0.9365	179.5	194.1	3.23	1.4799	.....	0.346	0.079	0.083	0.057	....	....	....
4	0.9371	173.5	194.0	3.63	.....	.....	.....	.....	.....	.....	1.14	0.98	....
5	0.9364	178.3	191.5	4.74	1.4822	.....	0.330	0.056	0.057	0.018	1.32	....	....
6	0.9358	180.0	191.1	3.05	1.4802	.....	0.352	0.049	0.105	0.021	....	....	....
7	0.9413	181.2	189.9	3.45	.....	.....	0.350	0.070	0.109	0.005	....	....	....
Aver..	0.9371	178.6	191.6	3.54	1.4814	47.48	0.346	0.066	0.086	0.025	1.21	1.04	0.72
SAMPLE No. 33.													
1	0.9427	179.3	191.6	7.12	1.4827	47.65	0.533	0.305	0.059	0.020	1.10	0.95	0.73
2	0.9426	183.9	191.9	6.62	.....	47.20	0.506	0.310	0.046	0.020	....	1.07	....
3	0.9430	182.1	198.0	6.79	1.4825	.....	0.598	0.306	0.058	0.010	....	....	....
4	0.9428	171.5	193.8	7.48	.....	.....	.....	.....	.....	.....	1.15	1.05	....
5	0.9430	182.5	194.9	9.35	1.4836	.....	0.480	0.250	0.042	0.016	1.23	....	....
6	0.9421	182.9	190.8	6.20	1.4721	.....	0.485	0.233	0.065	0.021	....	....	....
7	0.9428	186.2	189.7	6.40	.....	.....	0.510	0.300	0.069	0.007	....	....	....
Aver..	0.9427	181.2	192.9	7.14	1.4802	47.42	0.518	0.284	0.056	0.015	1.16	1.02	0.73
SAMPLE No. 34.													
1	0.9366	180.2	191.8	3.49	1.4808	49.41	0.242	0.055	0.047	0.017	1.08	0.79	0.81
2	0.9370	182.9	191.6	3.14	.....	47.58	0.237	0.071	0.036	0.013	....	0.98	....
3	0.9374	182.0	198.1	3.31	1.4799	.....	0.310	0.056	0.058	0.032	....	....	....
4	0.9381	176.5	194.1	3.43	.....	.....	.....	.....	.....	.....	1.18	....	....
5	0.9369	179.4	191.4	3.66	1.4814	.....	0.210	0.045	0.020	0.042	1.26	....	....
6	0.9368	182.5	190.7	3.17	1.4805	.....	0.239	0.042	0.051	0.017	....	....	....
7	0.9369	184.0	190.5	3.27	.....	.....	0.230	0.051	0.054	0.009	....	....	....
Aver..	0.9371	181.0	192.6	3.35	1.4806	48.49	0.244	0.053	0.044	0.021	1.17	0.88	0.81
SAMPLE No. 35.													
1	0.9388	184.3	191.1	5.03	1.4820	50.25	0.321	0.068	0.077	0.010	1.09	0.99	0.76
2	0.9392	186.6	192.0	4.80	.....	50.36	0.322	0.091	0.075	0.014	....	1.16	....
3	0.9393	184.9	194.7	4.96	1.4816	.....	0.343	0.013	0.024	0.009	....	....	....
4	0.9394	180.7	192.0	5.12	.....	.....	.....	.....	.....	.....	1.30	....	....
5	0.9391	184.0	191.1	5.47	1.4825	.....	0.310	0.063	0.070	0.017	1.33	....	....
6	0.9389	186.4	190.1	4.64	1.4717	.....	0.321	0.059	0.095	0.016	....	....	....
7	0.9430	187.6	190.5	5.05	.....	.....	0.300	0.068	0.111	0.006	....	....	....
Aver..	0.9396	184.9	191.6	5.01	1.4794	50.30	0.319	0.060	0.077	0.012	1.24	1.07	0.79

[a] Boemer method, using ether.
[b] Extraction of dry soap, using petrolic ether.
[c] Boemer method, using petrolic ether.

The higher results obtained by method No. 1 probably can be accounted for by the fact that ether dissolves more soap than petrolic ether.[1] In view of this slight difference between the results obtained by methods Nos. 1 and 2, all of which can be explained, the sub-committee recommends leaving the selection of the method to the operator. But one analyst used method No. 3. His results are lower than the other two. Inasmuch as the method offers no advantages, it is recommended that it be not generally used.

TABLE III.—AMOUNT OF UNSAPONIFIABLE MATTER.

Sample No.	Kind of Oil.	Average of all Results, per cent.		
		Method No. 1.[a]	Method No. 2.[b]	Method No. 3.[c]
1	Raw	1.12	0.96	....
2	Raw	1.13	0.93	....
3	Raw	1.04	0.99	....
4	Raw	1.22	0.99	....
30	Raw	1.10	1.04	....
31	Raw	1.08	1.03	....
32	Boiled	1.21	1.04	0.72
33	Boiled	1.16	1.02	0.73
34	Boiled	1.17	0.88	0.81
35	Boiled	1.24	1.07	0.76

[a] Regular Boemer method, using ether.
[b] Extraction of dry soap, using petrolic ether.
[c] Boemer method, using petrolic ether.

HEXABROMIDE DETERMINATION.

The sub-committee feels that progress has been made toward making this determination feasible for general application. Your attention is directed to the report of G. W. Thompson. He there gives in detail slight modifications of the Eibner method which have enabled him to secure consistent results. Following these suggestions another operator was enabled to secure results which, except in two instances, checked those of Mr. Thompson very closely.

[1] Lewkowitch, 1904, Vol. 1, page 294.

Following is a summary of the points which may have been responsible for errors in this determination:

1. Bromination at too low a temperature. The precipitate seems to be more crystallin or coarser and therefore filters more easily when formed at a temperature not lower than $-10°$ C.

2. Failure to wash the asbestos pad free of mother liquor before any more precipitate is added thereto.

3. Failure to keep the pad and precipitate wet with ether at all times by making each addition of precipitate or washing ether, immediately upon the liquid being filtered off.

TABLE IV.—AVERAGES OF ALL RESULTS ON BOILED OIL.

Sample No.	Specific Gravity.	Iodine Number.	Acid Number.	Saponification Number.	Refractive Index at 25° C.	Percentage of				
						Unsaponifiable Matter.	Ash.	Manganese.	Lead.	Calcium.
24	0.9422	181.3	7.99	191.0	1.4831	0.836	0.366	0.064	0.104	0.018
25	0.9472	178.9	6.34	192.2	1.4841	0.885	0.642	0.040	0.372	0.023
27	0.9393	186.7	5.87	192.0	1.4843	0 650	0.228	0.047	0 055	0 017
29	0.9440	180.1	5.00	191.9	1.4825	0.597	0.590	0.052	0.290	0 019
32	0.9371	178.6	3.54	191 6	1.4814	1.12	0.346	0.086	0.066	0.025
33	0 9427	181.2	7.14	192.9	1 4802	1.09	0.518	0.056	0.284	0 015
34	0 9371	181.0	3 35	192.6	1.4806	1 02	0 244	0 044	0.053	0.021
35	0 9396	184.9	5 01	191.6	1.4794	1.16	0 319	0.077	0.060	0.012
Aver....	0.9411	181.6	5.53	191.9	1.4819	0.919	0.406	0.058	0.160	0.018
Max....	0.9472	186 7	7 99	192 9	1.4843	1.16	0.642	0.086	0.372	0 025
Min...	0.9371	178.6	3.35	191.0	1.4794	0 597	0.228	0.040	0.053	0.012

4. Failure to keep the acids protected from the air from the moment they are removed from the atmosphere of hydrogen until brominated. They change rapidly in a manner that lowers their content of insoluble hexabromides.

The sub-committee thinks this to be a most important determination in ascertaining the purity of linseed oil and therefore urges that this advance toward a sure method be followed up by more work on the part of those interested so that limits for the percentage of insoluble hexabromides may be incorporated later in our specifications.

Table IV contains averages of all the results reported by the committee on boiled oil except those of sample No. 26, which showed so high a percentage of unsaponifiable matter that it was considered abnormal and therefore omitted.

The results just reported add no new features to those of our last report, except the determination of the insoluble hexabromides. These seem to average about the same as for raw linseed oil.

The sub-committee feels that the data in Table IV are sufficient to warrant the basing of specifications thereon; therefore, it proposes and recommends for adoption as standard the Specifications for Purity of Boiled Linseed Oil from North American Seed, appended to this report.[1]

These specifications are intended to include boiled linseed oil of both the linoleate and the resinate type, it being optional with the purchaser to specify either.

PROPOSED AMENDMENTS OF EXISTING SPECIFICATIONS.

The sub-committee furthermore recommends that the Standard Specifications for Purity of Raw Linseed Oil from North American Seed (Serial Designation: D1-13)[2] be amended as follows:

Section 1.—Change the minimum iodine number (Hanus) from 178 to 180.

Section 2: Unsaponifiable Matter.—Add at the end the words: "Or, any accurate method involving the extraction of the dried soap may be used."

The comments of the seven analysts previously referred to are given in the Appendix to this report.

The thanks of the sub-committee were extended to the Bureau of Chemistry, to those three laboratories which obtained the samples, to the Midland Linseed Products Co., to the Archer-Daniels Linseed Co., to the National Lead Co., and to the American Linseed Co. for the samples contributed.

Respectfully submitted on behalf of the sub-committee,

GLENN H. PICKARD,
Chairman.

[1] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.
[2] 1914 Year-Book, p. 335.

APPENDIX.

COMMENTS OF ANALYSTS.

Analyst No. 1—G. W. Thompson.

In the determination of the hexabromide number, Eibner's method was followed in detail for the recovery of the fatty acids. Instead of preparing a a 10-per-cent solution of the fatty acids in ether, as recommended by Eibner, I found the following procedure to give equally accurate results, especially in warm weather, when ether solutions are difficult to handle.

The pure fatty acids were poured into small vials holding approximately 2.0 g. when full and tightly corked. In this way, the fatty acids can be preserved for a considerable period without appreciable change. To make the test, the contents of one of the vials was poured into a weighed Erlenmeyer flask of 100-cc. capacity, flask and contents reweighed, and the fatty acids dissolved in 20 cc. of ether. I found 1.9 to 2.0 g. a convenient quantity to work with.

The brominizing process was carried out exactly as prescribed by Eibner. Four determinations were generally made at once, that is, four flasks were placed in a large bath of freezing mixture, allowed to reach a temperature of $-10°$ C, then bromine was added, one drop at a time, first to flask No. 1, then to flask No. 2, and so on until 0.5 cc. had been added to each flask. This required about 20 minutes. The second 0.5 cc. of bromine was added two drops at a time, and where four determinations are run at once, this will require between 10 and 15 minutes. The advantage of working with this number is that there is no delay and little danger of adding the bromine too rapidly. The time consumed for brominizing four tests was about 30 minutes. For measuring the bromine, I used a small burette, which could be conveniently held in one hand.

After the flasks had stood in the freezing mixture at $-10°$ C for tw hours, the filtering and washing was carried out as follows: A small wash bottle containing ether was placed in a separate freezing bath and the contents cooled to $-10°$ C. The tip of the bottle was made to deliver a very fine stream. The time required to deliver the proper amount of wash ether was determined by experiment and can be judged very closely.

The flask was removed from the freezing bath and the mother liquor carefully decanted. The precipitate was then washed down with a fine stream of ether, using about 5 cc., and the precipitate and wash ether shaken thoroughly and allowed to settle out in the freezing bath. This washing by decantation was repeated three times. The precipitate was then transferred to a Gooch crucible, and the flask was washed out with about 5 cc. of ether. It is seldom that any precipitate will be found adhering to the flask, but if such is the case, it can be removed with an ordinary rubber policeman. The precipi-

tate on the Gooch crucible was allowed to drain, using a gentle suction if necessary, but care should be taken to prevent the precipitate from becoming dry. Washing was continued on the Gooch crucible, stirring up the precipitate each time with a fine stream of ether, and allowing it to drain almost dry, until the wash ether appeared colorless. Strong suction was then applied and the precipitate freed from the liquid. The Gooch crucible was removed and placed in a steam bath which was held at 80° C., and dried for one hour. The liquid in the filtering flask will be found to be about 50 cc., and should not exceed this amount.

In following out this method results have been obtained, which agree closely with those reported by Eibner.

ANALYST NO. 2.—G. H. PICKARD.

Raw Oils.—For the determination of the amount of unsaponifiable matter, we proceeded as described by Wright.[1] We made many determinations of the percentage of insoluble hexabromides the results of which were neither uniform nor satisfactory. Our main sources of trouble were in filtration which proceeded very slowly. The mat became plugged so tightly that the wash portions of ether would not pass through. The results were high.

When we followed the method as outlined in the report of Mr. G. W. Thompson the whole operation went smoothly. We used a large wooden tub filled with freezing mixture which could easily be kept at −10° C, for the period of time necessary. When we failed to wash the mother liquor from the first decantation out of the filter pad with clear ether, trouble ensued. Light suction was used.

Boiled Oils.—We used the same method for the determination of the ash and its constituents that we reported in 1913. After repeated trials we failed to obtain concordant results on the percentage of rosin present and therefore do not include them in this report. The unsaponifiable matter was determined by the same method employed by us for raw oil which is incorporated in this report.

ANALYST NO. 3.—E. W. MARTIN.

In reference to ash determinations, 25 g. were burned slowly and the residue burned to ash at moderate redness. The ash was then dissolved in HCl, H_2SO_4 added, and evaporated until sulfuric-acid fumes were evolved. Then regular slag analysis followed to determine the calcium and manganese.

ANALYST NO. 4.—P. H. WALKER.

No comments.

ANALYST NO. 5.—E. W. BOUGHTON.

Raw Oils.—In using Eibner's method for the determination of the yield of hexabromide, I was unable to obtain precipitates which, when dried, were white and not sintered. All the dried precipitates, the amounts of which are

[1] "Analysis of Oils and Allied Substances," p. 111.

recorded below, were yellow and sintered. I therefore do not wish to give these figures in my report and merely offer them for comparison with those of other analysts who may have had more success with the method than I.

Sample No.	1	2	3	4
Hexabromides, per cent	47.64	44.03	55.85	50.40
	48.31	45.88	54.96	51.02
	49.09	.....	54.44	.....

Boiled Oils.—Two methods were used in the determination of lead, manganese and chromium. The results are given below.

Method No. 1 is given in Vol. XIII of the Proceedings of the Society, page 384.

Method No. 2 is as follows: Dissolve the ash in hot dilute HNO_3 with the addition of a little 3-per-cent H_2O_2 solution. Filter, wash, and dilute to 250 cc. Pipette out 100 cc. and determine Pb therein by precipitation as $PbCrO_4$ in

ANALYSES OF BOILED LINSEED OILS.

Sample No.	Lead, per cent.		Manganese, per cent.		Calcium, per cent.	
	Method No. 1.	Method No. 2.	Method No. 1.	Method No. 2.	Method No. 1.	Method No. 2.
32	0.055	0.066	0.051	0.069	0.018	0.017
	0.057	.....	0.063	0.068	0.018	0.029
33	0.262	0.237	0.044	0.042	0.016	0.013
	0.238	0.275	0.039	0.043	0.016	0.020
34	0.043	0.042	0.018	0.035	0.041	0.012
	0.046	0.040	0.022	0.034	0.042	0.027
35	0.063	0.067	0.066	0.072	0.016	0.022
	0.062	0.061	0.073	0.069	0.017	0.022

dilute HNO_3 solution.[1] Pipette out 25 cc. of the original filtrate and determine Mn therein by the bismuthate method. Pipette out 100 cc. of the original filtrate into a 250-cc. graduated flask. Add an excess of NH_4OH, warm, and pass in H_2S. Dilute to 250 cc. and filter; pipette out 200 cc. of the filtrate and determine Ca therein by precipitation as oxalate, finally weighing as oxide in the usual way.

The low results for Mn in samples Nos. 32 and 34 by method No. 1, show that the Mn was not completely precipitated by the $NH_4OH+H_2O_2$.

Experimental work on solutions containing known amounts of Pb and Ca showed that the two can not be quantitatively separated by precipitating the Pb as $PbSO_4$.

ANALYST NO. 6.—S. S. VOORHEES.

No comments.

[1] McDonnell's Method, *Proceedings*, Assn. Agr. Chem., pp. 40–42 (1910).

ANALYST NO. 7.—D. A. KOHR.

Herewith enclosed I send a record to date of the work that has been done by Mr. Mougey on the linseed oils from the American Society for Testing Materials. The iodine numbers of the fatty acids and the hexabromide determinations were made on only two of the oils by another of our operators last summer. He was unable to check his results on hexabromides, and this work was for that reason not continued at that time. Since then we have not had an opportunity to take it up again. Since the determinations of the iodine numbers on the fatty acids are more readily made with the hexabromide determinations, they also have not been done for the reasons given above.

The determinations of specific gravity were made at room temperatures and corrected to the standard temperatures by means of the factor given in the publication of the Society.[1]

I am not certain about the results on calcium. In the determination of calcium in the ash of the boiled oils, we did not previously remove the manganese. The ashes contain rather large amounts of phosphates and we thought that any simple method of removing the manganese would also remove the calcium, for calcium phosphate is precipitated by making a solution alkaline with ammonia if the solution contains calcium and phosphates in solution. In the methods of analysis as given in the committee reports, in all cases where a method of analysis is given, the manganese is separated from calcium in a solution that contains phosphates and is alkaline with NH_4OH.

Our method of analysis was to take the filtrate from the lead determination, containing manganese, calcium, and phosphates in solution, make alkaline with NH_4OH and then acid with acetic acid, precipitate the calcium as oxalate by adding ammonium oxalate, and then make the solution alkaline with NH_4OH. This gave a precipitate containing all the calcium as calcium oxalate and at least some manganese and phosphates in addition. We titrated this precipitate with $KMnO_4$ in the usual manner.

We believe that this method should give the proper results, provided that the lead was removed as sulfate or as sulfide. In our work, however, the lead was removed as chromate. This of course gives chromates in the filtrate, and although we have found that when calcium is high and manganese is low, as is usually the case with varnishes, this gives correct results, we are not so sure that the method is equally applicable to boiled oils where the manganese is high and the calcium is low. We believe that in this case some manganese may be oxidized to the peroxide and be present in the precipitate along with the calcium oxalate and, when the precipitate is treated with H_2SO_4, this peroxide of manganese would act on the calcium oxalate and thus cause our calcium results to run low.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XI, p. 211 (1911).

REPORT OF SUB-COMMITTEE VI ON DEFINITIONS OF TERMS USED IN PAINT SPECIFICATIONS.

The definitions which Committee D-1 had already reported to the Society having been referred back at the annual meeting in 1914, Sub-Committee VI has met and recommends for adoption as standard the following definitions[1] as substitutes for those given. In some cases comments on the definitions as recommended are also given.

Respectfully submitted on behalf of the sub-committee,

G. W. THOMPSON,
Chairman.

[1] These definitions are not reprinted here, but they appear, as amended at the annual meeting, in the 1915 Year-Book.—ED.

REPORT OF SUB-COMMITTEE VIII ON METHODS OF ANALYSIS OF PAINT MATERIALS.

Methods compiled from the literature, under the title of proposed Tentative Methods for Routine Analysis of White Pigments, are submitted for the consideration of Committee D-1 as to their suitability for the routine analysis or factory control of white pigments.[1] These methods are based on those submitted last year, but are not intended to supplant them. They have been prepared for convenience and to make possible more rapid work in the routine testing of pure pigments. For more accurate work, or for the complete analysis of pigments, especially those containing impurities, the methods given in our report of last year are to be used.[2]

Respectfully submitted on behalf of the sub-committee,

F. W. SMITHER,
Chairman.

[1] These methods are not reprinted here, but they appear, as amended at the annual meeting, in the 1915 Year-Book.—ED.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, pp. 269–280 (1914).

REPORT OF SUB-COMMITTEE X ON INSPECTION OF WHITE-PAINT TEST FENCE AT WASHINGTON, D. C.

To obviate the necessity of referring to previous reports, the general plan of this test as first reported in 1911, and as finally recommended, consisted briefly in applying some 120 white paints made of 13 single pigments in primary, binary, ternary, and quarternary combinations to yellow-poplar panels. The paints were designed on the volume basis, but were also reported on the weight basis as a matter of comparison.

It was intended that the formulas used would show the behavior of the single and combined pigments under the existing conditions, and also would indicate the influence of the various combinations in a progressive manner. All of these paints were ground to a standard spreading consistency, determined by viscosity, based on the consistency recommended by several representative paint manufacturers. The composition of the vehicle was agreed upon by the sub-committee.

The paints were applied to selected lumber under standard conditions, by experienced painters, dried indoors under uniform conditions, and finally exposed on government land at the Agricultural Experiment Station at Arlington, Virginia, in August, 1912. At the time the test was started the fence was some 200 ft. back from the river at normal stages, but since, the improvement and reclamation of the water front has temporarily flooded this area, so the normal water level now stands within 10 to 15 ft. of the fence. This condition has existed since last summer and will probably last a year longer before the flats are reclaimed.

Full details of the test can be obtained by reference to the previously published reports. From these reports it will be noted that all reasonable precautions were taken to control conditions so that the pigment was the main variable considered in the test.

The marked failure of some of the standard pigments indicates, however, that some deviation from standard practice may have caused their erratic behavior. Criticism has been made since the test has progressed that the painted panels should have been dried out of doors between coats, though as far as known this point has not been raised prior to the starting of this test; that the consistency determined by viscosity and a uniform addition of volatile thinner and drier may not have been the best reduction for the individual paints, and that the site for the exposure would not have been selected if it had been known that water would ultimately stand within 10 ft. of the fence. It is necessary to state these possibilities so as to qualify any conclusions which may be drawn.

The tests themselves have been most instructive and will add to the general knowledge of paint technology by indicating the possible influence of the many factors which affect final results.

Table I, appended to the report, records the results of the two inspections made during the past year and shows the condition of the paints after 26 and 32 months' exposure. The remarks concerning these inspections are shown side by side and the composition of the pigment on both volume and weight basis is given.

During April, 1915, photographs on 5 by 7-in. plates were taken of each panel, the same being taken on the west side of the fence by supporting the camera on a tripod which was hung from the middle rail and held at such a distance from the fence that it was in accurate focus for full-size exposures. The point arbitrarily selected for these photographs was between one-third and one-half of the distance below the top of the lower panel so that adjoining panels were taken on one plate. Another set of full-size exposures was taken by one of the members of the sub-committee at the same time using a 4 by 5-in. film-pack camera and a tripod so as to insure accurate focus. He selected an average area on the east side of the lower panel, which was sponged off with clean water before photographing.

These two sets of prints show the condition of the surface at the points photographed far better than they can be described, but due to unavoidable differences in exposure, developing, and

printing, they do not show true color values. To furnish this information another set of photographs has been made such as was reported last year, in which a board freshly painted with a white zinc-oxide paint was exposed on the middle rail between each five sets of paint formulas. This furnishes a relative indication of the color values of the paints.

When the inspection was made last October it was suggested that the darkening of some of the paints might be due to spor or fungus growth. Samples of some of the dried powder removed from a few of the darkened panels were examined by Miss Vera K. Charles, Assistant Mycologist of the Bureau of Plant Industry, Department of Agriculture, who reported that a preliminary examination showed that all the samples but one contained a fungus growth, but it was impossible to positively identify the organism at that time, as in some of the samples it was in the vegetative stage only. The indications were that the fungus was a Phoma, but further work was necessary before a positive statement could be made. The Department of Agriculture is continuing this investigation and it is hoped that this may be done now that the weather permits.

The full-size photographs of each paint record the condition of the paint film with sufficient fidelity to permit both photographic enlargement and lantern projection. They will be made a part of the sub-committee's record in conjunction with the inspection, but it is felt that no illustration for the Proceedings could be made which would bring out the detailed structure shown by either the negatives or the prints, and therefore the cost is not warranted.

The condensed results of inspections are as follows:[1]

PRIMARY PIGMENTS.

Panels Nos. 101, 102 and 103, three types of basic lead carbonate. Nos. 101 and 102 show darkened and alligatored surfaces; No. 103 shows a darkened surface with checking.

Panels Nos. 104 and 105, two types of zinc oxide. Clean, white surfaces with a form of checking having a tendency to scale.

Panel No. 106, basic lead sulfate. Failure.

Panel No. 107, leaded zinc oxide. Clean surface; fine checking.

[1] For description and manufacturer's designation of pigments used, see the Report of Sub-Committee J of Committee D-1, *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 406 (1913).

BINARY COMPOSITION.

Panels Nos. 201 to 208, inclusive, four-fifths basic lead carbonate and one-fifth of one of the following pigments in the order named: zinc oxide, basic lead sulfate, silicious material, asbestine, clay, calcium carbonate, calcium sulfate, barium sulfate.

The proportions stated are by volume in every case in this report.

The mixture of lead and zinc pigments shows a clean surface, with fine checking and slight chalking. The other mixtures show darkened surfaces, checking, or alligatoring and various degrees of chalking.

Panels Nos. 209 to 216, inclusive, one-half basic lead carbonate and one-half of one of the other pigments named in the previous group. The first two show clean surfaces with more or less checking and but slight chalking. The others show darkened surfaces, checking, or alligatoring, and various degrees of chalking.

Panels Nos. 217 to 219, inclusive, three-fifths basic lead carbonate with two-fifths, respectively, of one of the following pigments: zinc oxide, French process; zinc oxide, American process; basic lead sulfate.

The mixtures of lead and zinc pigments show fairly clean surfaces with more or less checking and a tendency to scale on one instance and slight chalking. The mixture of lead pigments (Panel No. 219) is somewhat darkened and show considerable alligatoring.

Panel No. 220. Not in test.

Panels Nos. 221 to 227, inclusive, one-half zinc oxide and one-half of one of the following pigments in the order named: basic lead sulfate, silicious material, asbestine, clay, calcium sulfate, calcium carbonate, barium sulfate.

This group shows white, clean surfaces with fine checking having tendency towards scaling. Slight chalking shown by most of the panels.

Panels Nos. 228 to 233, inclusive, one-half basic lead sulfate and one-half of one of the following pigments in the order named: silicious material, asbestine, clay, calcium carbonate, calcium sulfate, barium sulfate. This group shows darkening, alligatoring and slight chalking.

Panels Nos. 234 and 235, two-fifths basic lead carbonate and three-fifths French process zinc oxide and American process zinc oxide, respectively. These show clean, white surfaces, fine checking with a tendency towards scaling and slight chalking.

TERNARY COMPOSITION.

Panels Nos. 301 to 307, inclusive, one-third basic lead carbonate, one-third zinc oxide, and one-third of one of the following pigments in the order named: basic lead sulfate, silicious material, asbestine, clay, calcium carbonate, calcium sulfate, barium sulfate. These show clean, white surfaces with various degrees of checking and chalking.

Panels Nos. 308 to 314, inclusive, one-half basic lead carbonate, one-fourth zinc oxide, and one-fourth of one of the pigments named in the group of panels Nos. 301 to 307 in the order shown. These show white surfaces, generally fine checking, and slight to medium chalking.

Panels Nos. 315 to 321, inclusive, one-fourth basic lead carbonate, one-half zinc oxide, and one-fourth of one of the pigments used in the group of panels Nos. 301 to 307, in the order named. These show clean white surfaces, slight to medium checking, with a slight tendency to scale in one instance, and medium chalking.

Panels Nos. 322 to 328, inclusive, one-fourth basic lead carbonate, one-fourth zinc oxide, and one-half of one of the pigments used in the group of panels Nos. 301 to 307, in the order named. These show very clean, white surfaces, medium to very slight checking, and medium chalking.

Panels Nos. 329 to 334, inclusive, one-third basic lead sulfate, one-third zinc oxide, and one-third of one of the following pigments in the order named: silicious material, asbestine, clay, calcium carbonate, calcium sulfate, barium sulfate. These show very clean, white surfaces with medium checking and chalking. Panel No. 334 has a tendency to scale.

Panels Nos. 335 to 340, inclusive, one-half basic lead sulfate, one-fourth zinc oxide, and one-fourth of one of the pigments used in the group of panels Nos. 329 to 334, in the order named. These show white, clean surfaces with slight chalking and medium checking. Slight longitudinal cracking is shown in some instances.

Panels Nos. 341 to 346, inclusive, one-fourth basic lead sulfate, one-half zinc oxide, and one-fourth of one of the pigments used in the group of panels Nos. 329 to 334, in the order named. These show white, clean surfaces with medium checking and chalking and a tendency to scale in two instances.

Panels Nos. 347 to 370, inclusive, include four groups of paints prepared from varying mixtures of basic lead carbonate, basic lead sulfate, and pigments such as silicious material, asbestine, clay, calcium carbonate, calcium sulfate, and barium sulfate. These paints show darkened surfaces, alligatoring, and various degrees of chalking.

QUARTERNARY COMPOSITION.

Panels Nos. 401 to 406, inclusive, consist of one-fourth basic lead carbonate, one-fourth basic lead sulfate, one-fourth zinc oxide, and one-fourth of one of the following pigments in the order named: silicious material, asbestine, clay, calcium carbonate, calcium sulfate and barium sulfate. This group shows clean, white surfaces with slight checking and chalking.

SUMMARY.

The indications from this inspection are similar to those outlined in the summary of the report presented at the last annual meeting.[1] The panels painted with composite paints containing both zinc and lead pigments show superiority to those painted with single primary pigments.

Attention is called to some apparent inconsistencies between

[1] *Proceedings*, Am. Soc. Test Mats., Vol. XIV, Part I, p. 292 (1914).

reports of inspections of 1914 and 1915. It is believed that they are largely due to the difficulty of attaching a precise meaning to the terms used. It is the intention of the sub-committee to attempt to standardize the terms employed in paint inspections.

It is the opinion of the sub-committee that these tests have afforded information of great value.

It is recommended that this test be discontinued, allowing the fence to stand or the panels otherwise cared for, and that another series of paint tests be considered which may include repainting of some of the old panels.

A report from Miss Vera K. Charles, Assistant Mycologist, Bureau of Plant Industry, Department of Agriculture, covering a preliminary investigation of the organic life present on the paints, appears as an Appendix to this report.

Respectfully submitted on behalf of the sub-committee,

S. S. VOORHEES,
Chairman.

TABLE I.—RESULTS OF INSPECTION.

PRIMARY PIGMENTS.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
101	Basic lead carbonate (Dutch).....	1	100	100	Alligatored; some chalking.	Panel darkened; surface alligatored; slight chalking; spotted.
102	Basic lead carbonate (Carter's)....	2	100	100	Shows heavy or marked alligatoring; more chalking than Panel No. 101.	Not quite so darkened as panel No. 101; deep alligatoring; slight chalking.
103	Basic lead carbonate (Mild).....	3	100	100	Checking; more chalking than Panels Nos. 101 and 102.	Surface darkened in spots; medium chalking; slight checking shown.
104	Zinc oxide (French).....	4	100	100	White and clean; marked cracking of a longitudinal nature exhibited.	Checking with tendency to scale; no chalking; panel white and clean, but has grayish tone.
105	Zinc oxide (American).....	5	100	100	White and clean; marked cracking of a longitudinal nature exhibited.	Same as Panel No. 104 except that panel is whiter.
106	Basic lead sulfate.....	6	100	100	Darkened and decayed; scaled in many places to the wood; failed.	Failed.
107	Leaded zinc oxide.....	7	100	100	White; shows longitudinal cracks.	Clean surface; very slight chalking; fine checking.

BINARY COMPOSITION.

201	Basic lead carbonate (Dutch).....	1	80	83	White; checking shown; very slight chalking.	Clean surface, slight chalking; fine checking.
	Zinc oxide (American).....	5	20	17		
202	Basic lead carbonate (Dutch).....	1	80	81	Darkened; alligatored; considerable chalking.	Darkened surface; alligatored; slight chalking.
	Basic lead sulfate.....	6	20	19		
203	Basic lead carbonate (Dutch).....	1	80	91	Darkened; heavy checking; slight chalking.	Darkened surface; alligatoring slightly more pronounced than on Panel No. 202; slight chalking.
	Siliceous material (silica).....	8	20	9		
204	Basic lead carbonate (Dutch).....	1	80	90	Darkened; heavy checking; medium chalking.	Surface alligatored; slight chalking.
	Silicate (asbestine).....	9	20	10		

TABLE I.—*Continued.*

BINARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
205	Basic lead carbonate (Dutch).....	1	80	91	Darkened; slight checking; medium chalking.	Surface darkened; very slight checking; slight chalking.
	Clay (China clay).....	10	20	9		
206	Basic lead carbonate (Dutch).....	1	80	91	Considerable darkening; checking; medium chalking.	Surface darkened; marked surface checking; slight chalking.
	Calcium carbonate (whiting).....	11	20	9		
207	Basic lead carbonate (Dutch).....	1	80	92	Small dark streaks; checking; slight chalking.	Surface darkened; checking; medium chalking.
	Calcium sulfate.....	12	20	8		
208	Basic lead carbonate (Dutch).....	1	80	86	Slight darkening; heavy chalking; no checking.	Fairly clean; slight checking; heavy chalking.
	Barium sulfate (barytes).....	13	20	14		
209	Basic lead carbonate (Dutch).....	1	50	55	White; checking and slight cracking.	Fairly clean; considerable checking with tendency to scale; slight chalking.
	Zinc oxide (French).....	4	50	45		
210	Basic lead carbonate (Dutch).....	1	50	51	Darkening and chalking; no checking or cracking.	Fairly clean; very slight checking; no chalking.
	Basic lead sulfate.....	6	50	49		
211	Basic lead carbonate (Dutch).....	1	50	71	Darkened in streaks; checking; mildew.	Somewhat darkened and spotted; considerable checking; slight chalking.
	Siliceous material (silica).....	8	50	29		
212	Basic lead carbonate (Dutch).....	1	50	70	Darkened; checking; medium chalking.	Heavy surface checking; darkened panel with lots of spots; considerable surface dirt; medium chalking.
	Silicate (asbestine).....	9	50	30		
213	Basic lead carbonate (Dutch).....	1	50	71	Darkened; considerable chalking; slight checking and cracking.	Surface darkened; slight checking; slight chalking.
	Clay (China clay).....	10	50	29		
214	Basic lead carbonate (Dutch).....	1	50	71	Darkened; alligatored; considerable chalking.	Surface darkened; alligatored; medium chalking.
	Calcium carbonate (whiting).....	11	50	29		
215	Basic lead carbonate (Dutch).....	1	50	74	Darkened; heavy checking; considerable chalking.	Surface darkened; alligatored; slight chalking.
	Calcium sulfate.....	12	50	26		
216	Basic lead carbonate (Dutch).....	1	50	61	White except streaks on two boards; medium chalking.	Darkened in spots; very slight checking; medium chalking.
	Barium sulfate (barytes).....	13	50	39		
217	Basic lead carbonate (Dutch).....	1	60	64	White; checking; slight chalking.	Darkened in spots; fine checking; slight chalking; fairly clean.
	Zinc oxide (American).....	5	40	36		

TABLE I.—*Continued.*

BINARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
218	Basic lead carbonate (Dutch).....	1	60	64	White; checking and cracking in places; medium chalking.	Considerable checking with tendency to scale; slight chalking; fairly clean surface.
	Zinc oxide (French).....	4	40	36		
219	Basic lead carbonate (Dutch).....	1	60	61	Darkened; heavy checking; considerable chalking.	Somewhat darkened surface; considerable surface alligatoring; slight chalking.
	Basic lead sulfate.....	6	40	39		
220	Zinc oxide (American).....	5	50	45	Not in test.	Not in test.
	Basic lead carbonate (Dutch).....	1	50	55		
221	Zinc oxide (American).....	5	50	46	White; fine checking and cracking; slight chalking.	White surface; considerable checking with tendency to scale; considerable chalking.
	Basic lead sulfate.....	6	50	54		
222	Zinc oxide (American).....	5	50	67	White; fine checking and cracking.	White surface; very fine checking with tendency to scale; slight chalking.
	Siliceous material (silica).....	8	50	33		
223	Zinc oxide (American).....	5	50	66	White; fine cracking; slight chalking.	Same as Panel No. 222.
	Silicate (asbestine).....	9	50	34		
224	Zinc oxide (American).....	5	50	67	White; fine longitudinal cracking.	Same as Panel No. 222.
	Clay (China clay).....	10	50	33		
225	Zinc oxide (American).....	5	50	67	White; checking and cracking; slight chalking; flaking in streaks on some boards.	Same as Panel No. 222.
	Calcium carbonate (whiting).....	11	50	33		
226	Zinc oxide (American).....	5	50	70	Slightly discolored; fine checking; slight chalking.	Same as Panel No. 222.
	Calcium sulfate.....	12	50	30		
227	Zinc oxide (American).....	5	50	56	White; checking; very slight chalking.	Same as Panel No 222.
	Barium sulfate (barytes).....	13	50	44		
228	Basic lead sulfate.....	6	50	71	Very dark; heavy checking; much chalking.	Darkened surface; alligatored; very slight chalking.
	Siliceous material (silica).....	8	50	29		
229	Basic lead sulfate.....	6	50	69	Same as Panel No. 228.	Same as Panel No. 228.
	Silicate (asbestine).....	9	50	31		
230	Basic lead sulfate.....	6	50	71	Very dark; heavy checking; much chalking; considerable flaking shown.	Same as Panel No. 228.
	Clay (China clay).....	10	50	29		

TABLE I.—*Continued.*

BINARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
231	Basic lead sulfate	6	50	71	Quite dark; heavy checking; considerable chalking.	Same as Panel No. 228.
	Calcium carbonate (whiting)	11	50	29		
232	Basic lead sulfate	6	50	72	Very dark; considerable checking; medium chalking.	Same as Panel No. 228.
	Calcium sulfate	12	50	28		
233	Basic lead sulfate	6	50	60	Failed. Marked darkening, checking, and flaking, with general disintegration of coats.	Has practically failed, due to scaling.
	Barium sulfate (barytes)	13	50	40		
234	Zinc oxide (American)	5	60	55	White; some checking and fine cracking; very slight chalking.	White surface; fine checking with tendency to scale; slight chalking.
	Basic lead carbonate (Dutch)	1	40	45		
235	Zinc oxide (French)	4	60	55	White; fine checking; very slight chalking.	Same as Panel No. 234.
	Basic lead carbonate (Dutch)	6	40	45		

TERNARY COMPOSITION.

301	Basic lead carbonate (Dutch)	1	33.3	36	White; fine checking; very slight chalking.	Clean surface; considerable checking; medium chalking.
	Zinc oxide (American)	5	33.3	29		
	Basic lead sulfate	6	33.3	35		
302	Basic lead carbonate (Dutch)	1	33.3	45	Same as Panel No. 301.	White surface; fine checking; medium chalking.
	Zinc oxide (American)	5	33.3	37		
	Siliceous material (silica)	8	33.3	18		
303	Basic lead carbonate (Dutch)	1	33.3	44	White; fine checking; slight cracking and chalking.	Same as Panel No. 302.
	Zinc oxide (American)	5	33.3	36		
	Silicate (asbestine)	9	33.3	20		
304	Basic lead carbonate (Dutch)	1	33.3	45	White; checking; slight chalking.	Very clean white surface; fine checking; medium chalking.
	Zinc oxide (American)	5	33.3	37		
	Clay (China clay)	10	33.3	18		
305	Basic lead carbonate (Dutch)	1	33.3	45	White; checking; fine cracking; slight chalking.	White surface; considerable fine checking with tendency to scale; medium chalking.
	Zinc oxide (American)	5	33.3	37		
	Calcium carbonate (whiting)	11	33.3	18		

TABLE I.—*Continued*.

TERNARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
306	Basic lead carbonate (Dutch).....	1	33.3	46	White; fine checking; slight chalking.	Very white surface; very fine checking; medium chalking.
	Zinc oxide (American).....	5	33.3	38		
	Calcium sulfate.....	12	33.3	16		
307	Basic lead carbonate (Dutch).....	1	33.3	40	White; fine checking; slight chalking.	White surface; very fine checking; very slight chalking.
	Zinc oxide (American).....	5	33.3	33		
	Barium sulfate (barytes).....	13	33.3	27		
308	Basic lead carbonate (Dutch).....	1	50	53	White; very slight cracking; slight chalking.	White surface; very fine checking; medium chalking.
	Zinc oxide (American).....	5	25	25		
	Basic lead sulfate.....	6	25	22		
309	Basic lead carbonate (Dutch).....	1	50	62	White; very slight cracking; slight checking and chalking.	Same as Panel No. 308.
	Zinc oxide (American).....	5	25	25		
	Siliceous material (silica).....	8	25	13		
310	Basic lead carbonate (Dutch).....	1	50	62	White; fine checking and cracking; medium chalking.	Same as Panel No. 308.
	Zinc oxide (American).....	5	25	25		
	Silicate (asbestine).....	9	25	13		
311	Basic lead carbonate (Dutch).....	1	50	62	Same as Panel No. 310.	Same as Panel No. 308.
	Zinc oxide (American).....	5	25	25		
	Clay (China clay).....	10	25	13		
312	Basic lead carbonate (Dutch).....	1	50	62	White; fine checking and cracking; medium chalking.	White surface; medium surface checking; medium chalking.
	Zinc oxide (American).....	5	25	25		
	Calcium carbonate (whiting).....	11	25	13		
313	Basic lead carbonate (Dutch).....	1	50	63	Same as Panel No. 312.	Very white surface; extremely fine checking; very slight chalking.
	Zinc oxide (American).....	5	25	26		
	Calcium sulfate.....	12	25	11		
314	Basic lead carbonate (Dutch).....	1	50	58	White; checking; medium chalking.	Practically the same as Panel No. 313.
	Zinc oxide (American).....	5	25	23		
	Barium sulfate (barytes).....	13	25	19		
315	Basic lead carbonate (Dutch).....	1	25	28	White; checking and slight cracking; medium chalking.	White surface; medium checking with slight tendency to scale; medium chalking.
	Zinc oxide (American).....	5	50	45		
	Basic lead sulfate.....	6	25	27		

TABLE I.—*Continued.*

TERNARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
316	Basic lead carbonate (Dutch).....	1	25	33	Same as Panel No. 315.	White, clean surface; medium checking; medium chalking.
	Zinc oxide (American).....	5	50	54		
	Siliceous material (silica).....	8	25	13		
317	Basic lead carbonate (Dutch).....	1	25	33	Same as Panel No. 315.	Same as Panel No. 316.
	Zinc oxide (American).....	5	50	54		
	Silicate (asbestine).....	9	25	13		
318	Basic lead carbonate (Dutch).....	1	25	33	Same as Panel No. 315.	Same as Panel No. 316.
	Zinc oxide (American).....	5	50	54		
	Clay (China clay).....	10	25	13		
319	Basic lead carbonate (Dutch).....	1	25	33	Same as Panel No. 315.	Same as Panel No. 316.
	Zinc oxide (American).....	5	50	54		
	Calcium carbonate (whiting).....	11	25	13		
320	Basic lead carbonate (Dutch).....	1	25	33	Same as Panel No. 315.	Clean, white surface; very slight checking; medium chalking.
	Zinc oxide (American).....	5	50	55		
	Calcium sulfate.....	12	25	12		
321	Basic lead carbonate (Dutch).....	1	25	30	Same as Panel No. 315.	Clean, white surface; slight checking; medium chalking.
	Zinc oxide (American).....	5	50	50		
	Barium sulfate (barytes).....	13	25	20		
322	Basic lead carbonate (Dutch).....	1	25	27	White; checking and medium chalking.	Very white and clean; medium checking; medium chalking.
	Zinc oxide (American).....	5	25	22		
	Basic lead sulfate.....	6	50	51		
323	Basic lead carbonate (Dutch).....	1	25	38	White; checking; no chalking.	Very white surface; very slight checking; medium chalking.
	Zinc oxide (American).....	5	25	31		
	Siliceous material (silica).....	8	50	31		
324	Basic lead carbonate (Dutch).....	1	25	38	Dirty in spots; no cracking or checking; slight chalking.	Same as Panel No. 323.
	Zinc oxide (American).....	5	25	31		
	Silicate (asbestine).....	9	50	31		
325	Basic lead carbonate (Dutch).....	1	25	38	No checking or cracking; medium chalking.	Very white, smooth, dense surface; very slight checking; medium chalking.
	Zinc oxide (American).....	5	25	31		
	Clay (China clay).....	10	50	31		

TABLE I.—*Continued.*

TERNARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
326	Basic lead carbonate (Dutch).....	1	25	38	Slight discoloration; heavy checking; medium chalking.	Clean white surface; checking; medium chalking.
	Zinc oxide (American).....	5	25	31		
	Calcium carbonate (whiting).....	11	50	31		
327	Basic lead carbonate (Dutch).....	1	25	40	Slight discoloration; very slight checking; slight chalking.	Very white and clean; extremely slight checking; medium chalking.
	Zinc oxide (American).....	5	25	32		
	Calcium sulfate.....	12	50	28		
328	Basic lead carbonate (Dutch).....	1	25	32	Same as Panel No. 327.	Very white and clean; extremely slight checking; slight chalking.
	Zinc oxide (American).....	5	25	26		
	Barium sulfate (barytes).....	13	50	42		
329	Basic lead sulfate.....	6	33.3	44	White; fine checking; medium chalking.	Very white and clean; medium checking; medium chalking.
	Zinc oxide (American).....	5	33.3	37		
	Siliceous material (silica).....	8	33.3	19		
330	Basic lead sulfate.....	6	33.3	44	White; no checking or cracking; medium chalking.	Same as Panel No. 329.
	Zinc oxide (American).....	5	33.3	37		
	Silicate (asbestine).....	9	33.3	19		
331	Basic lead sulfate.....	6	33.3	44	Same as Panel No. 330.	Same as Panel No. 329.
	Zinc oxide (American).....	5	33.3	37		
	Clay (China clay).....	10	33.3	19		
332	Basic lead sulfate.....	6	33.3	44	White; checking; medium chalking.	White and clean; checking; medium chalking.
	Zinc oxide (American).....	5	33.3	37		
	Calcium carbonate (whiting).....	11	33.3	19		
333	Basic lead sulfate.....	6	33.3	45	Slightly discolored; no checking or cracking; slight chalking.	White and clean; checking; medium chalking.
	Zinc oxide (American).....	5	33.3	39		
	Calcium sulfate.....	12	33.3	16		
334	Basic lead sulfate.....	6	33.3	39	White; fine checking and cracking; medium chalking.	White and clean; checking with tendency to scale; slight chalking.
	Zinc oxide (American).....	5	33.3	34		
	Barium sulfate (barytes).....	13	33.3	27		
335	Basic lead sulfate.....	6	50	61	Same as Panel No. 334.	White and clean; checking; slight chalking.
	Zinc oxide (American).....	5	25	26		
	Siliceous material (silica).....	8	25	13		

TABLE I.—*Continued.*

TERNARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
336	Basic lead sulfate	6	50	61	White; slight surface cracking; considerable chalking.	White and clean; medium checking; slight chalking.
	Zinc oxide (American)	5	25	26		
	Silicate (asbestine)	9	25	13		
337	Basic lead sulfate	6	50	61	Same as Panel No. 336.	Same as Panel No. 336.
	Zinc oxide (American)	5	25	26		
	Clay (China clay)	10	25	13		
338	Basic lead sulfate	6	50	61	White; surface cracking shown; chalking.	White and clean; medium checking with slight longitudinal cracking; slight chalking.
	Zinc oxide (American)	5	25	26		
	Calcium carbonate (whiting)	11	25	13		
339	Basic lead sulfate	6	50	62	White; some chalking; no checking or cracking.	White and clean; medium checking with slight longitudinal cracking; slight chalking.
	Zinc oxide (American)	5	25	26		
	Calcium sulfate	12	25	12		
340	Basic lead sulfate	6	50	56	White; surface cracking shown; considerable chalking.	Same as Panel No. 339.
	Zinc oxide (American)	5	25	24		
	Barium sulfate (barytes)	13	25	20		
341	Basic lead sulfate	6	25	32	White; checking; medium chalking.	White and clean; medium checking; slight chalking.
	Zinc oxide (American)	5	50	54		
	Siliceous material (silica)	8	25	14		
342	Basic lead sulfate	6	25	32	Same as Panel No. 341.	White surface; medium checking; slight chalking.
	Zinc oxide (American)	5	50	54		
	Silicate (asbestine)	9	25	14		
343	Basic lead sulfate	6	25	32	White; very fine checking; medium chalking.	White and clean; medium checking; medium chalking; slight tendency to scale.
	Zinc oxide (American)	5	50	54		
	Clay (China clay)	10	25	14		
344	Basic lead sulfate	6	25	32	White; checking; surface scaling in spots; very slight chalking.	White and clean; checking; slight chalking.
	Zinc oxide (American)	5	50	54		
	Calcium carbonate (whiting)	11	25	14		
345	Basic lead sulfate	6	25	33	Same as Panel No. 344.	White and clean; medium checking; medium chalking.
	Zinc oxide (American)	5	50	55		
	Calcium sulfate	12	25	12		

TABLE I.—*Continued.*

TERNARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
346	Basic lead sulfate	6	25	29	Same as Panel No. 344.	White and clean; medium checking; medium chalking; marked tendency to scale.
	Zinc oxide (American)	5	50	50		
	Barium sulfate (barytes)	13	25	21		
347	Basic lead carbonate (Dutch)	1	33.3	42	Very dark; alligatored; heavy chalking.	Darkened surface; marked surface checking; some chalking.
	Basic lead sulfate	6	33.3	40		
	Siliceous material (silica)	8	33.3	18		
348	Basic lead carbonate (Dutch)	1	33.3	42	Same as Panel No. 347.	Darkened surface; alligatored; some chalking.
	Basic lead sulfate	6	33.3	40		
	Silicate (asbestine)	9	33.3	18		
349	Basic lead sulfate	6	33.3	40	Same as Panel No. 347.	Very dark surface; alligatored; some chalking.
	Basic lead carbonate (Dutch)	1	33.3	42		
	Clay (China clay)	10	33.3	18		
350	Basic lead carbonate (Dutch)	1	33.3	42	Same as Panel No. 347.	Same as Panel No. 349.
	Basic lead sulfate	6	33.3	40		
	Calcium carbonate (whiting)	11	33.3	18		
351	Basic lead carbonate (Dutch)	1	33.3	43	Same as Panel No. 347.	Same as Panel No. 349.
	Basic lead sulfate	6	33.3	41		
	Calcium sulfate	12	33.3	16		
352	Basic lead carbonate (Dutch)	1	33.3	38	Same as Panel No. 347.	Same as Panel No. 349.
	Basic lead sulfate	6	33.3	36		
	Barium sulfate (barytes)	13	33.3	26		
353	Basic lead carbonate (Dutch)	1	50	60	Same as Panel No. 347.	Same as Panel No. 349.
	Basic lead sulfate	6	25	28		
	Siliceous material (silica)	8	25	12		
354	Basic lead carbonate (Dutch)	1	50	60	Same as Panel No. 347.	Same as Panel No. 349.
	Basic lead sulfate	6	25	28		
	Silicate (asbestine)	9	25	12		
355	Basic lead carbonate (Dutch)	1	50	60	Very dark; alligatored; heavy chalking.	Very dark surface; alligatored; some chalking.
	Basic lead sulfate	6	25	28		
	Clay (China clay)	10	25	12		

TABLE I.—*Continued.*

TERNARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
356	Basic lead carbonate (Dutch).....	1	50	60	Same as Panel No. 355.	Same as Panel No. 355.
	Basic lead sulfate.....	6	25	28		
	Calcium carbonate (whiting).....	11	25	12		
357	Basic lead carbonate (Dutch)....	1	50	60	Same as Panel No. 355.	Same as Panel No. 355.
	Basic lead sulfate.....	6	25	29		
	Calcium sulfate.....	12	25	11		
358	Basic lead carbonate (Dutch).....	1	50	55	Same as Panel No. 355.	Same as Panel No. 355.
	Basic lead sulfate.....	6	25	27		
	Barium sulfate (barytes).....	13	25	18		
359	Basic lead carbonate (Dutch).....	1	25	30	Same as Panel No. 355.	Same as Panel No. 355.
	Basic lead sulfate.....	6	50	58		
	Siliceous material (silica).....	8	25	12		
360	Basic lead carbonate (Dutch).....	1	25	30	Same as Panel No. 355.	Same as Panel No. 355.
	Basic lead sulfate.....	6	50	58		
	Silicate (asbestine).....	9	25	12		
361	Basic lead carbonate (Dutch).....	1	25	30	Same as Panel No. 355.	Same as Panel No. 355
	Basic lead sulfate.....	6	50	58		
	Clay (China clay).....	10	25	12		
362	Basic lead carbonate (Dutch).....	1	25	30	Same as Panel No. 355.	Same as Panel No. 355.
	Basic lead sulfate.....	6	50	58		
	Calcium carbonate (whiting).....	11	25	12		
363	Basic lead carbonate (Dutch).....	1	25	30	Same as Panel No. 355.	Same as Panel No. 355.
	Basic lead sulfate.....	6	50	58		
	Calcium sulfate.....	12	25	12		
364	Basic lead carbonate (Dutch).....	1	25	28	Same as Panel No. 355.	Same as Panel No. 355.
	Basic lead sulfate.....	6	50	52		
	Barium sulfate (barytes).....	13	25	20		
365	Basic lead carbonate (Dutch).....	1	25	36	Same as Panel No. 355.	Same as Panel No. 355.
	Basic lead sulfate.....	6	25	35		
	Siliceous material (silica).....	8	50	29		

TABLE I.—*Continued.*

TERNARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
366	Basic lead carbonate (Dutch) Basic lead sulfate Silicate (asbestine)	1 6 9	25 25 50	36 35 29	Very dark; alligatored; heavy chalking.	Very dark surface; alligatored; some chalking.
367	Basic lead carbonate (Dutch) Basic lead sulfate Clay (China clay)	1 6 10	25 25 50	36 35 29	Same as Panel No. 366.	Same as Panel No. 366.
368	Basic lead carbonate (Dutch) Basic lead sulfate Calcium carbonate	1 6 11	25 25 50	36 35 29	Same as Panel No. 366.	Same as Panel No. 366.
369	Basic lead carbonate (Dutch) Basic lead sulfate Calcium sulfate	1 6 12	25 25 50	38 36 26	Same as Panel No. 366.	Same as Panel No. 366.
370	Basic lead carbonate (Dutch) Basic lead sulfate Barium sulfate (barytes)	1 6 13	25 25 50	30 29 41	Same as Panel No. 336.	Surface is much cleaner and shows less alligatoring than Panels Nos. 349 to 369, inclusive.

QUARTERNARY COMPOSITION.

401	Basic lead carbonate (Dutch) Zinc oxide (American) Basic lead sulfate Siliceous material (silica)	1 5 6 8	25 25 25 25	31 25 30 14	White; slight surface cracking; medium chalking.	White and clean; slight checking; slight chalking.
402	Basic lead carbonate (Dutch) Zinc oxide (American) Basic lead sulfate Silicate (asbestine)	1 5 6 9	25 25 25 25	31 25 30 14	Same as Panel No. 401.	Same as Panel No. 401.
403	Basic lead carbonate (Dutch) Zinc oxide (American) Basic lead sulfate Clay (China clay)	1 5 6 10	25 25 25 25	31 25 30 14	Same as Panel No. 401.	Same as Panel No. 401.

TABLE I.—*Continued.*

QUARTERNARY COMPOSITION.

Panel No.	Constituents.	Pigment No.	Percentage by		Remarks.	
			Volume.	Weight.	Inspection made October 28, 1914, by Voorhees, Gardner, Macnichol and Polk.	Inspection made April 16, 1915, by Voorhees, Gardner, Macnichol and Gibboney.
404	Basic lead carbonate (Dutch).....	1	25	31	White; checking and slight surface cracking; medium chalking.	Same as Panel No. 401.
	Zinc oxide (American).....	5	25	25		
	Basic lead sulfate.....	6	25	30		
	Calcium carbonate (whiting).....	11	25	14		
405	Basic lead carbonate (Dutch).....	1	25	31	White; slight surface checking; medium chalking.	Same as Panel No. 401.
	Zinc oxide (American).....	5	25	26		
	Basic lead sulfate.....	6	25	31		
	Calcium sulfate.....	12	25	12		
406	Basic lead carbonate (Dutch).....	1	25	29	White; checking; slight surface cracking; medium chalking.	Same as Panel No. 401.
	Zinc oxide (American).....	5	25	24		
	Basic lead sulfate.....	6	25	28		
	Barium sulfate (barytes).....	13	25	19		

APPENDIX.

FUNGI OCCURRING ON THE WHITE-PAINT TEST FENCE AT WASHINGTON, D. C.

By Vera K. Charles.

On April 28, 1915, collections were made of fungi present on the white-paint test fence at Washington, D. C. The collections were made in order to determine the fungi causing the discoloration of the paint. This being the object, the investigation has been purely taxonomic in character, and therefore the important economic bearing of fungi on paint problems has not been considered. In this instance, as in all cases in which a logical scientific interpretation is essential to the solution of an economic problem, the strictly technical work has preceded the inauguration of experiments to evolve methods of control or eradication. Several species of fungi have been isolated during the course of the present investigation, but certain forms were early eliminated, as it was recognized that they were of secondary interest. Any exposed surface will collect spores of various kinds, and therefore it was necessary to separate the different forms and study their behavior in order to determine the fungi directly responsible for the discoloration of the paint. In the present case the two organisms directly responsible for the blackening of the paint are a species of *Phoma* and *Dematium pullulans*. These two forms were grown artificially on cornmeal in 100-cc. flasks.

Phoma.—This fungus belongs to the *Sphaerioidaceae*, a family of fungi having its spores (reproductive bodies) borne in globose, more or less spherical, membranaceous or carbonaceous bodies termed pycnidia. Fungi belonging to this genus cause many serious diseases in plants and most of the species have living plants as their hosts, though a few are reported occurring on posts, bark of trees, insects, manure, and one species (*P. pigmentivora*) has been reported as occurring in paints. The

spores of *Phoma* are hyaline, minute and numerous. In these experiments with artificial cultures, pycnidia were developed from spores in about two weeks. Growth from the collections made in the fall (November), was not as rapid as that resulting from collections in April, the phenomenon being probably explained by the more vigorous activity exhibited by plants in the spring.

Dematium pullulans.—The systematic position of this fungus has been the subject of considerable discussion, but in the present investigation we use this name to designate the luxuriant fungus growth occurring on the paint test fence in the spring. It consists of irregular, brown, septate mycelium which forms numerous, more or less irregular, one-celled brown spores. In old cultures the spores appear two to three-celled. In addition to these colored spores, numerous hyaline, thin-walled, oval spores are formed which are especially abundant in the young culture. This organism is known to produce still another spore form, but only two forms were observed in the cultures made during the present work. Observations made during these experiments suggest the close relation of this species of *Phoma* and *Dematium pullulans*, but the most important and practical data deduced from field and laboratory work are the knowledge concerning the different spore forms, their correlation with weather conditions, and their comparative vitality.

These fungi were isolated and grown in pure culture from all of the collections. The relative amount of the fungi obtained from the different paint samples was very marked, but no striking difference in the luxuriance of growth in artificial media was apparent.

This technical study of the fungi causing discoloration of paints is of interest to the paint industry only as there can be derived from it an economic application of scientific knowledge, namely, the preservation of paints from the attacks of fungi. The practical form of experimentation must consist in growing pure cultures of the fungi on media to which have been added certain chemicals which would prove toxic to the organisms but would not have a deleterious effect on the paint.

REPORT OF SUB-COMMITTEE XI ON PAINT THINNERS OTHER THAN TURPENTINE.

During the past year Sub-Committee XI has held two general meetings with an average attendance of 6 out of a total membership of 17. Numerous sectional meetings have also been held. The work carried on during the year has been a continuation of that begun during the previous year, namely, the selection of methods of tests for the various qualities of material, which should be covered in specifications coming within the scope of this sub-committee. Methods of test have been investigated and specifications drawn for apparatus and methods of manipulation.

The results of the year's work are summarized as follows:

Solvent Power.—The section of the sub-committee which considered this matter reports that owing to the wide diversity in the nature of the materials which thinners are required to dissolve, there does not as yet appear to be any method proposed that gives any promise of satisfying the conditions which a standard test for solvent power would be called upon to fulfil. Thinners for gum compounds would require different solvent properties from those used in aniline stains, and again, different from those used with blown oils.

The sub-committee therefore is of the opinion that no method as yet proposed can be offered as a standard test for solvent power.

Evaporation Rate.—A section of the sub-committee having this matter in charge tried out two methods of test which are described as follows:

Method A.—One cubic centimeter of the thinner to be tested is placed in a flat-bottom circular metal dish, about 8 cm. in diameter, and at the same time in another similar dish there is placed the same quantity of a pure chemical to be used as a standard of comparison. In the tests conducted pure benzol was used as the standard. The metal dishes, which in this case were paint-can covers, containing the liquids are exposed to similar atmospheric conditions until both have evaporated to such a degree that when the dishes are tipped up on edge no flow of liquid is visible. The time elapsing from the moment of placing the liquids in the dishes to the end point is recorded. The

evaporation factor is computed as the ratio between the time taken by the thinner under test to the time taken by the pure benzol.

Method B.—Ten cubic centimeters of the material to be tested is pipetted into an ordinary flat-bottom glass crystallizing dish, 2½ in. in diameter, 1 in. in height. This dish is placed upon a steam bath, care being taken that as much of the bottom as possible is exposed to the steam. It is weighed at definite periods of 15 or 30 minutes until the evaporation is complete. The weight of the original material should be calculated from its specific gravity.

Results of the tests made are given in Tables I and II.

The wide diversity in the results obtained in both of these series of tests does not encourage further consideration of these methods.

Specific Gravity.—Previous to the time when the recommendation which Sub-Committee XII on Turpentine purposed presenting to Committee D-1, was heard of, this sub-committee had decided to recommend the Westphal balance as the standard apparatus for determining specific gravity. But upon learning that Sub-Committee XII proposed to recommend other methods, it was decided to hold this matter over until the two sub-committees could endeavor to come to an agreement in the matter, and so avoid confusion of methods. Therefore no recommendation on the subject of specific gravity is offered at the present time.

Distillation.—The methods generally employed in the petroleum-distillate and in the coal-tar-products industries are so nearly alike that there appears to be little difficulty in adjusting these differences so as to produce a single method fully acceptable to both classes of producers and to users generally.

A tentative test and apparatus, entitled proposed Tentative Test for Distillation of Paint Thinners other than Turpentine, is appended to this report for consideration or temporary approval.[1]

This tentative test has been submitted to letter ballot of the sub-committee, which consists of 17 members, of whom 9 have voted affirmatively, 6 negatively, and 2 have refrained from voting.

Flash Point.—The series of experiments outlined in the report of 1914 were carried out with the cooperation of 35 laboratories, with a total of 64 operators making tests. The number of tests in detail are as shown in Table III.

[1] This test is not reprinted here, but it appears in the 1915 Year-Book.—ED.

TABLE I.—RESULTS OF EVAPORATION TESTS: METHOD A.

Material.	Time of Evaporation, minutes.		
	Weiss.	Mackenzie.	Veitch.
Benzole, pure	6	15	11
Benzole, 90	8	25	22
Solvent Naphtha	77	142	305
Petroleum Spirits, No. 1	218	270	240

TABLE II.—RESULTS OF EVAPORATION TESTS: METHOD B.

Material.	Elapsed Time, minutes.	Residue, per cent.		
		Veitch.	Lindsay.	Mackenzie.
Benzole, pure	13	0.0	.....	...
	15	0.0	0.009	0.0
	30	...	0.008	...
	45	...	0.006	...
	60	...	0.006	...
Benzole, 90	13	...	.....	...
	15	0.06	0.007	...
	18	0.00	.....	0.0
	30	...	0.000	...
Solvent Naphtha	13	...	.....	...
	15	53.1	0.246	...
	30	4.3	0.171	2.56
	45	...	0.159	..
	60	3.2	0.146	0.22
	90	hard	.....	0.13
Petroleum Spirits, No. 1	15	72.3	8.96	...
	30	44.3	0.006	15.74
	45	...	0.003	...
	60	6.4	0.000	0.23
	90	0.2	.....	0.00

TABLE III.—FLASH POINT TESTS.

Type of Tester.	Method Used.	Number of Laboratories.	Number of Operators.	Number of Tests Made.
Tagliabue	A	28	51	108
Tagliabue	B	28	51	94
Elliot	(?)	25	45	100
Abel-Pensky	A	12	17	33
Abel-Pensky	B	14	20	39
Abel	A	8	16	39
Abel	B	8	15	33

Total number of tests made	446
Total number of laboratories reporting	35
Number of laboratories reporting on 1 tester	10
Number of laboratories reporting on 2 testers	12
Number of laboratories reporting on 3 testers	16
Number of laboratories reporting on 4 testers	2
Total number of operators reporting	64

It was found upon examination of the data reported that the glass cups used in various Tagliabue open testers varied in weight from 72 to 108 g. and that they varied in capacity from 67 to 100 cc. Such variations could not but have an effect on the results. It was therefore decided to repeat the flash-point tests by members of this sub-committee using standardized glass cups, also a standardized metal cup in the Tagliabue open tester, and with standardized thermometers and a uniform flame tube. There was also included the new model tester of the U. S. Bureau of Mines, which was not available when the 1914 series of tests were made, and the Abel-Pensky tester. Three grades of thinness were furnished for the tests; flashing at about 80, 100 and 120° F., respectively, in an open-cup test.

The results of this 1915 series of flash-point tests have not all been received at the time of making this report. No recommendation can therefore be made at this time in the matter of flash point.

Respectfully submitted on behalf of the sub-committee,

CLOYD M. CHAPMAN,
Chairman.

[EDITOR'S NOTE.—For Discussion on this report, see page 272.]

REPORT OF SUB-COMMITTEE XII ON TURPENTINE.

The sub-committee purposed investigating during the past year (1) methods for determining flash point; (2) methods for determining residue on evaporation; (3) methods to secure more concordant results on distillation; and also, in the preparation of the final specifications for turpentine, to consider results obtained by members of the sub-committee and others, with the specifications and methods submitted at the last annual meeting of the Society.

The sub-committee has not been able to devise a reliable method for the determination of residue on evaporation, and the work which has been done by Sub-Committee XI on Paint Thinners other than Turpentine has not justified the inclusion at this time of a method for the determination of flash point.

The sub-committee has done no special work for the purpose of improving the method of distillation and of securing more concordant results, but has confined its efforts to the individual experience of members during the past year with the methods of distillation reported at the last annual meeting. The sub-committee is of the opinion that the method for distillation there laid down, is sufficiently definite for practical purposes, in conjunction with the other items of the specifications.

During the year the sub-committee sent a copy of the following letter to producers and users of turpentine:

MARCH 25, 1915.

Attached hereto you will find copy of "Proposed Specifications for Turpentine," as prepared by Sub-Committee XII on Turpentine of this Society, after extended examinations of a large number of samples of gum turpentine and wood turpentines, both steam and destructively distilled.

As the value of these specifications depends largely upon their general adoption as a basis for buying and selling, we are sending this letter to a number of producers and consumers before presenting same to the Society for final action.

We would thank you to give these proposed specifications your careful attention and place your comments and suggestions in the hands of the Secretary at your earliest convenience. For the sake of convenience in replying will you kindly follow as closely as possible the following questions:

1. (*a*) (For Producers). Can you produce regularly a grade of turpentine conforming fully with the attached proposed specifications?

(*b*) (For Consumers). Would the attached proposed specifications meet with your approval as a basis for purchasing your turpentine requirements?

2. Would you suggest any changes in the specifications, or the addition of further tests?

3. Do the methods of test as outlined meet with your approval?

4. Would you consider the adoption of two or more specifications, covering several grades or qualities of turpentine, advisable?

It will materially assist the sub-committee's work if you can send copies of specifications which you are using and have found satisfactory. In offering suggestions as to changes in the specifications, we ask that, when possible you attach analysis or other data on samples of known source, upon which your suggestions are based.

The investigations of this sub-committee during the years 1913–14 are published in the Proceedings of the American Society for Testing Materials, Vol. XIV, Part I, pages 316–344 (1914).

Respectfully,

F. P. VEITCH,
Chairman, Sub-Committee XII on Turpentine.

Seven replies, outside of the members of the sub-committee, were received. Two replies were from producers of wood turpentine and five were from paint and varnish manufacturers.

The producers of wood turpentine expressed the opinion that under Section 1, "Classes" the sentence reading "The purchaser, when ordering under these specifications, should specify," etc., should be omitted, on the ground that if the turpentine otherwise met the specifications, it is to be assumed that the turpentine is entirely satisfactory for the purpose for which the turpentine is used. One of the paint and varnish makers took essentially the same position. The other replies suggested no change in this section of the specifications.

The two producers of wood turpentine stated that they can and do produce wood turpentine regularly, which conforms fully with the proposed specifications. A number of consumers and also the wood-turpentine producers suggested that the specifications be changed somewhat; that the range of the specific gravity be decreased; that the percentage distilling at 170° C. be raised to 95 per cent; and that the limit for residue on polymerization also be raised. The consumers in general

state that turpentine complying with the specifications as outlined will be suitable for their uses.

The methods of analysis outlined were not criticized, except that there was one suggestion that it would be well to insert a correction for barometric pressure under the distillation test.

Practically all of those who replied, deemed that one set of specifications for one grade of turpentine is sufficient, it being held that specifications for two grades or qualities would be confusing.

A large number of results with the specifications and methods as suggested last year have come to the attention of the sub-committee. After careful consideration of these results, of the experience of the individual members of the sub-committee, and of communications from producers and users of turpentine, the proposed Standard Specifications for Turpentine appended hereto[1] were adopted by the sub-committee at a meeting held in Washington, April 16, 1915; four of the seven members of the sub-committee being present.

The second paragraph of Section 1 of the specifications submitted last year, beginning "The specifications do not attempt to differentiate," etc., has been omitted, as the thought is better expressed in the first paragraph and the statement conflicts somewhat with the succeeding paragraph.

The important changes in the specifications as submitted tentatively last year may be summarized as follows:

1. The range of the specific gravity has been decreased from 0.860–0.875 to 0.862–0.872.

2. The standard color has been defined.

3. The polymerization residue has been raised to 2 per cent, as some operators do not secure complete polymerization. Since the requirements for consistency, color and refractive index of residues remain the same, this change is deemed permissible.

Respectfully submitted on behalf of the sub-committee,

F. P. VEITCH,
Chairman.

[1] These specifications are not reprinted here, but they appear, as amended at the annual meeting, in the 1915 Year-Book.—ED.

REPORT OF SUB-COMMITTEE XIII ON SHELLAC.

In the report of Sub-Committee XIII on Shellac presented at the last annual meeting of the Society, it was mentioned that among methods of shellac analysis that for the determination of moisture was then under investigation. Work on this method has been completed, and the sub-committee desires to present the proposed Tentative Test for Moisture in Bleached Shellac, appended hereto.[1]

Respectfully submitted on behalf of the sub-committee,

A. C. LANGMUIR,
Chairman.

[1] This test is not reprinted here, but it appears, as amended at the annual meeting, in the 1915 Year-Book.—ED.

REPORT OF SPECIAL SUB-COMMITTEE ON SPECIFICATIONS FOR SAMPLING OF LIQUIDS.

Shortly after its organization, the sub-committee addressed a letter to various organizations or individuals known to be purchasers of large amounts of liquids used in protective coatings, asking for an outline of the methods in use for obtaining samples of such liquids from shipping containers. That part of the reply which gave the information asked was sent to each member. At a meeting held at Atlantic City, at which were present Messrs. S. S. Voorhees, C. M. Chapman, F. P. Veitch and G. H. Pickard, the whole question was thoroughly discussed. The sub-committee deemed it advisable to consider the sampling of liquids in containers capable of agitation separate from those which cannot be agitated, such as tank cars.

Liquids in Containers Capable of Agitation.—Inasmuch as thorough agitation is absolutely essential we recommend that just before the sample is drawn a test be made by inserting a rod with a wide end, long enough to scrape the bottom of the container to prove the absence of sediment thereon. In agitating a barrel it is advisable to add to the usual rolling motion, a vigorous shaking obtained by the application of power at each end of the barrel to cause violent rocking on the bilge, rolling the barrel meanwhile to bring all points of the perimeter to the top. As quickly as possible after agitation has ceased, insert a tube through the opening at such a rate that it may fill completely as it travels through the liquid. If the tube used is of too large a bore to permit of closing at the top a bottom closing device may be used, which permits the opening of the tube to reach the bottom of the container. We recommend that 10 per cent of the packages of a large shipment be samples. The samples may be examined separately, or combined, as desired.

Samples from Tank Cars.—In view of the difficulties—a few of which are mentioned—of securing thoroughly representative samples from tank cars, the sub-committee deems it inadvisable at this time to draw up specifications covering this condition of sampling.

It is obvious that a thief (a tube or other device for withdrawing a portion of any liquid from its container) inserted along any diameter of a cylindrical tank car cannot take a sample representing the contents thereof. The sub-committee realizes that if proper care is exercised in calculating the capacity of any section of the tank car, in designing the sampler and in carrying out the operation, an average sample can be obtained. Yet the difficulties attending the securing of a sample by such means as a thief whose cross-section is proportional to that of the tank car, or by drawing amounts with a cup device from different points (calculated to the volume of liquid per unit depth at that level) are so numerous and fraught with such risks of inaccuracy that it is deemed advisable to eliminate such methods from consideration. The fact that the presence or absence of foreign materials (such as water in oil) in the commodity shipped is not alone to be determined, lends force to this decision; for instance, in the case of linseed oil, where many specifications allow a certain percentage of matter in suspension, it is essential to have the samples show an average of material comprising the shipment.

Another general method of securing samples which permits of modifications is to draw a portion from the pipe line used to transfer the liquid from the tank car to storage tank. Inasmuch as conditions obtaining at various plants complicate the operation seriously, the sub-committee does not feel warranted in drawing up specifications.

If a suitable cock is placed in the bottom of the transfer line, preferably near the tank car, and the liquid dripping therefrom is caught, an average sample would be obtained. With constant orifice the variations in pressure on the line would be compensated. The use of this method is recommended wherever possible.

Another way is to take samples at regular intervals from the stream at point of efflux. To insure accuracy the stream must flow with constant head and the samples be taken frequently enough to obviate the effect of sudden variations of quality. It is seldom that access can be had to the stream at or near the tank car. This adds an element of uncertainty, emanating from the previous contents of the pipe line used to convey

the liquid from the tank car to the storage tank and the possibility of leaks in that line.

A third modification consists of the diversion into a suitable receptacle of a portion of the stream at the point of efflux by inserting a tube or V-shaped strip of metal therein. Spattering of the stream or appreciable variations in pressure would affect the accuracy of the method.

While the sub-committee regrets its inability to present for your consideration generally applicable specifications for sampling, it is hoped that you will either concur in its judgment not to attempt the apparently impossible, or else make available such information as may enable it to draw satisfactory specifications.

Respectfully submitted on behalf of the sub-committee,

GLENN H. PICKARD,
Chairman.

DISCUSSION ON THE REPORT OF COMMITTEE D-1.

Mr. Walker.

MR. P. H. WALKER (*Chairman of Committee D-1*).—At a meeting of Committee D-1, held on Thursday evening, June 24, the following amendments were made to the report of the committee as printed:

1. In the Proposed Standard Definitions of Terms Used in Paint Specifications (Report of Sub-Committee VI), insert a supplementary note under the definition of "gallon," reading: "This is the standard United States gallon."

2. In the Proposed Tentative Methods for Routine Analysis of White Pigments (Report of Sub-Committee VIII), make the following changes:

(*a*) Under the heading, "Zinc-Lead and Leaded-Zincs (Ozlo White)," change the last sentence in the first paragraph on "Total Lead and Zinc" to read as follows:

"Make filtrate from $PbSO_4$ alkaline with NH_4OH, then acid with HCl, add 3 cc. of concentrated HCl, heat to nearly boiling, and titrate the total zinc with potassium-ferrocyanide solution using uranium-acetate solution as an outside indicator and calculate to ZnO. (Iron, copper, or other interfering substances should be first removed as described by Low.)"

(*b*) Under "Soluble Zinc Sulfate," change "Boil" to "Heat nearly to boiling."

(*c*) Under "Sulfur Dioxide," after "Basic Sulfate of Lead" add the words "or Zinc Oxide."

(*d*) Under the heading "Lithopone," insert as a paragraph just above the paragraph headed "Zinc Sulfide" the following:

"*Zinc Oxide.*—Treat a 4-g. sample of the lithopone for 4 hours with 200 cc. of 1-per-cent acetic acid at room temperature, stirring occasionally. Filter by suction on a double filter paper and wash with cold water; add to the

clear filtrate 13 cc. of concentrated NH_4OH, neutralize with HCl and then add 3 cc. of concentrated HCl in excess. Heat to boiling and titrate with $K_4Fe(CN)_6$, using uranium-acetate solution as an outside indicator. Calculate to ZnO. Calculate this result to Zn, subtract from total Zn, and calculate the difference to ZnS. (Any $ZnCO_3$ or $ZnSO_4$ is included in the ZnO.)" Mr. Walker.

3. In the report of Sub-Committee X on Inspection of the White Paint Test Fence at Washington, D. C., replace the summary at the end by the following:

"The indications from this inspection are similar to those outlined in the summary of the report presented at the last annual meeting. The panels painted with composite paints containing both zinc and lead pigments show superiority to those painted with single primary pigments.

"Attention is called to some apparent inconsistencies between reports of inspections of 1914 and 1915. It is believed that they are largely due to the difficulty of attaching a precise meaning to the terms used. It is the intention of the sub-committee to attempt to standardize the terms employed in paint inspections.

"It is the opinion of the sub-committee that these tests have afforded information of great value.

"It is recommended that these tests be discontinued, allowing the fence to stand or the panels otherwise cared for, and that another series of paint tests be considered which may include repainting of some of the old panels.

"A report[1] from Miss Vera K. Charles, Assistant Mycologist, Bureau of Plant Industry, Department of Agriculture, covering a preliminary investigation of the organic life present on the paints, appears as an appendix to this report."

4. In the Proposed Standard Specifications for Turpentine (Report of Sub-Committee XII), make the following changes:

(*a*) In Section 2, change "shall" to "may," and omit the comma after "gum." Omit the marginal note "Appearance."

[1] See pp. 257–258.—ED.

Mr. Walker.

(*b*) In Section 3, add "or better" after "Standard."

(*c*) In Section 9, add "or better" after "Standard."

5. In the Proposed Tentative Test for Moisture in Bleached Shellac (Report of Sub-Committee XIII), under Method No. 1, transpose the second and third sentences.

Mr. Muer.

MR. HENRY F. MUER (*by letter*).—Referring to the proposed Test for Distillation of Paint Thinners other than Turpentine, most laboratories in which the testing of paint materials is incidental to other work would be likely to use condensers of the Liebig type. What is the advantage of the prescribed type?

Mr. Chapman.

MR. CLOYD M. CHAPMAN (*by letter*).—Replying to the question raised by Mr. Henry F. Muer as to reasons for recommending the particular trough type of condenser designated by Sub-Committee XI, of which the writer is chairman, in the proposed method for the distillation test, instead of a condenser of the Liebig type, I would state:

First.—The temperature of the end point of some of the heavier paint thinners is so high that a glass condenser would be very likely to break in service. This is not true of all paint thinners, but the standard method must be applicable to all and some of them run to such high temperatures that a glass condenser would not be safe.

Second.—The trough type of condenser does not require running water.

Third.—Some of the very volatile paint thinners require such low temperatures for condensation that very few laboratories have running water at a sufficiently low temperature and ice would be required to insure complete condensation. The trough type of condenser readily lends itself to the use of ice, whereas one of the circulating type does not.

Fourth.—While the Liebig type of condenser would ordinarily answer all purposes, the sub-committee felt that it should not recommend a type which is not adapted to the extreme cases and all conditions. Inasmuch as only one standard could be recommended, the trough type was the only one that could be chosen. No doubt for the average run of paint thinners in routine laboratory work the Liebig type is a satisfactory substitute.

REPORT OF COMMITTEE D-2

ON

STANDARD TESTS FOR LUBRICANTS.

Committee D-2 has held four meetings during the year, with an average attendance of seven members.

The committee has very carefully reconsidered its report of last year, which was referred back to it by the Society.

For the determination of viscosity, the committee reaffirms its recommendation of last year to the Society that the Saybolt Standard Universal Viscosimeter be the standard. The very careful investigation of Dr. C. W. Waidner of the Bureau of Standards, showing that the Saybolt instrument possesses as great accuracy as any other viscosimeter used for the determination of the viscosity of lubricants, confirms the previous opinion of the committee. The Saybolt viscosimeter is the instrument in practically universal use in the United States for the determination of the viscosity of lubricants, and possesses many other advantages covered by the committee's report of last year.

On the question of an alternate instrument for viscosity, the committee after very careful consideration has concluded that the adoption of an alternate instrument would entirely destroy the value of a standard instrument. The committee realizes, however, that there are many who for years past have used other instruments than the Saybolt and will probably continue to do so, and in order not to work undue hardship in these cases, the committee is now submitting, and will submit from time to time, conversion tables for converting readings on various viscosimeters into readings on the Saybolt Standard Universal Viscosimeter. Appended to this report will be found the result of the investigation of Doctor Waidner on conversion of readings on the Engler and Redwood viscosimeters into readings on the Saybolt Standard Universal Viscosimeter, and means to be taken for the standardization of the three viscosimeters is also covered. Since it is occasionally required that the viscosity of lubricants be expressed in terms of absolute viscosity, and since tables have already been prepared by

Dr. L. Ubbelohde for converting readings on the Engler instrument into absolute viscosity, conversion tables have also been added covering the conversion of readings on the Saybolt and Redwood instruments into terms of Engler.

The committee recommends that the proposed Standard Tests for Lubricants, appended hereto, covering Viscosity, Specific Gravity, Free Acid, and Cloud and Pour tests, be referred to letter ballot of the Society.

The committee has also under consideration standard methods of test for Saponification Value, Carbon Residue, Evaporation, Emulsification, Sulfur Determination and Differentiation, Precipitation, Flash and Fire Point, and Gumming.

This report has been submitted to letter ballot of the committee, which consists of 14 members. The following is the result of the ballot:

	AFFIRMATIVE.	NEGATIVE.
General Report	13	1
Standard Method for Vicosity	13	1
Standard Method for Specific Gravity	12	2
Standard Method for Free Acid	13	1
Standard Method for Cloud and Pour Test (Cold Test)	12	2

This report is seen to have received the approval of the committee by majority vote of those voting. Certain dissenting members, however, offer minority reports, which are appended to this report.

Respectfully submitted on behalf of the committee,

C. P. VAN GUNDY,
Chairman.

K. G. MACKENZIE,
Secretary.

[EDITOR'S NOTE.—For action taken on this report, see pages 27–28.

The proposed Standard Tests for Lubricants were referred back to the committee for such further investigations concerning items on which the committee is not in agreement as it may see fit to undertake. They appear on pages 279–283.

For Discussion on the report, see page 295.]

MINORITY REPORTS.

The undersigned members of Committee D-2, being unable to agree to the omission of certain methods of testing lubricants, beg leave to suggest the following amendment to the majority report:

Pour Test.

While the undersigned fully endorse the proposed method of first heating the oil to be tested to 150° F. and cooling down in air or water baths to about 75° F., they consider it of equal importance that a pour test should also be made of the sample of oil which has not been heated to the above indicated temperature prior to testing.

The general practice is and has been in this country and abroad, to make the cold or pour tests of oils without heating them to any specified high temperature. It is recommended, therefore, that a pour test also should be made of the original sample as received after it has been kept for one hour at a temperature of 75° F. before testing.

The undersigned feel that it would be a serious mistake for the American Society for Testing Materials not be recognize this amendment as proposed.

Respectfully submitted,

P. H. Conradson,
W. O. Dunbar.

The undersigned has refrained from signing the majority report of the committee to avoid giving the impression that the few methods so far covered by the committee are complete, and to suggest it be understood that future work of the committee will include their reconsideration as to revision and additions that may be found desirable, particularly as to the

inclusion of or reference to the important features of other methods that may appear to have been ignored.

For example, under viscosity and specific gravity, respectively, the statement that the Saybolt viscosimeter and Geissler pyknometer *shall* be used should be avoided, because other instruments are named in the report as being suitable for the same purposes. There are also on the market, or conveniently available, many other forms of viscosimeters and pyknometers which, if properly used, and provided conversion tables are used for the viscosimeters, give practically equivalent or identical results. Another reason that appears is that this Society rarely if ever names as its standard any machine or instrument when thereby preference is given to particular makers; and sufficient reason for doing so in either of these cases is not made apparent and it seems unnecessary and undesirable. As other methods than those already prepared are in contemplation and may eventually become part of this report, it seems urgent that an understanding on this point should be reached before further work is done by the committee in possibly the wrong direction.

Under specific gravity, the proposed methods would be very much more satisfactory to the large number of persons interested, and certainly no less valuable to experts in such matters, if they were more fully described, making each recognized method complete in itself, and in such a manner as to indicate in this and other cases that other instruments or methods suitable for the same purpose are not ignored. From the report no one can know what the Geissler pyknometer is like nor why it is preferred to the many other forms of pyknometers, nor except by inference why it is given priority over the Westphal balance or Baumé hydrometer. A brief description of the Bureau of Standards formula for the Baumé hydrometer could be made to define specific gravity clearly. The closing paragraph draws attention to this but not so fully as to make its meaning clear.

The free-acid method, like those for specific gravity, while no doubt accurate, is very meagerly described for any but the expert. All chemical terms should be given by name and not by symbol alone. In the method here proposed the indicator specified is phenolphthalein, without mention of any other

which might be used. This is the one prominent feature. By some the turmeric solution has been found applicable as the indicator for all oils, whereas phenolphthalein has in some instances failed and in others proven less decisive than the turmeric solution. There should be some statement in the method recognizing other known indicators, to the effect that the amount of caustic potash necessary to neutralize the acidity in the oil is to some extent dependent on the indicator used, and therefore precaution should be given that the method of determination as to the indicator and the limits of acidity to be allowed shall match, just as it is often necessary that apparently insignificant details even in apparently identical methods have to be given the most careful attention by buyer and seller to obtain correct results. As the measurement of the oil sample for test is more quickly done by taking its volume than its weight, this feature of the method should not be ignored. Whether the free acid should be reported as the number of milligrams of caustic potash necessary to neutralize the acidity in 1 g. of oil, may be questioned. It is no doubt a convenient way under many conditions, but inasmuch as this method of reporting does not tell the amount or nature of the acid accurately, it evidently would not include all that might be desired.

The proposed cloud and pour determinations for cold test—while definite tests clearly and accurately described—are apparently modifications of an old and recognized method, not however so generally used, it would appear, as some others. Until the proposed method is tried out there is some doubt that it is as convenient for rapid operation where any considerable number of samples are under test at the same time, and as the two methods do not necessarily give the same results, undoubtedly due to the heat treatment which the oil receives in the proposed method, it is questionable, as Dr. Conradson's amendment indicates, whether the existing methods of test should be abandoned even if the one here proposed be adopted.

The foregoing is the result largely of a comparison of the committee's proposed methods as presented in this report with the corresponding printed methods which have been in use successfully for 16, 20 and 25 years respectively by a laboratory accepting oils under a specification. By such a comparison

the Society's methods should, if anything, be found even more complete, inasmuch as the Society may well present the best it finds in all methods and not confine itself entirely to one method, even where it may be desirable to present one method of test for a given purpose completely, and only refer to other important features of other methods for the same purpose.

This minority report is offered in the belief that it will not lessen the value of the very considerable amount of work represented in the majority report, which work is fully recognized and appreciated by the undersigned.

Respectfully submitted,

W. O. DUNBAR.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROPOSED STANDARD TESTS FOR LUBRICANTS.[1]

Serial Designation: D—.

These standard tests are issued under the fixed designation D —; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ADOPTED, ——.

VISCOSITY.

The viscosity shall be determined by the Saybolt Standard Universal Viscosimeter, the approximate dimensions of which are as follows:

Diameter of overflow filling gage cup	51.0 mm.
Depth of overflow filling gage cup	13.0 "
Diameter of main cylindrical tube	30.0 "
Depth from starting head to outlet jet	113.0 "
Length of outlet jet	13.0 "
Diameter of outlet jet	1.8 "
Charging quantity	70.0 cc.

Fig. 1 represents the basic features of the instrument. Minor improvements are made in some cases in the fittings and means of temperature control. These improvements do not in any way affect the readings of the instrument.

[1] These tests were referred back to Committee D-2; see pp. 27–28.—ED.

Attention should be called to the fact that three instruments known as Saybolt "A," Saybolt "B" and Saybolt "C" were in use in this country to a certain extent a number of years ago. All of these instruments are obsolete, and should not be confused with the Saybolt Standard Universal Viscosimeter.

The standard temperatures for the determination of viscosity shall be 100, 130, or 210° F., the selection of the particular temperature to be governed by the viscosity of the oil.

Have the bath of water or oil *C* at such temperature that the oil to be tested in the tube *A* will be exactly at the standard temperature. Fill the tube *A* and the overflow *B* with carefully strained oil at a temperature slightly below standard

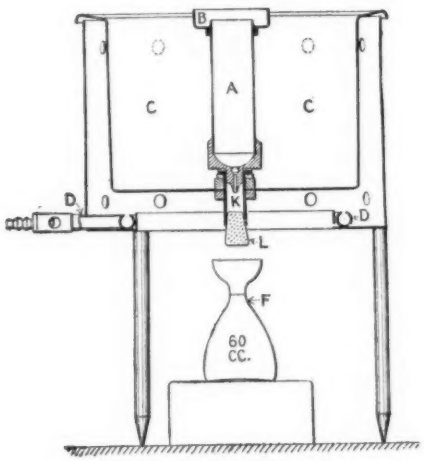


FIG. 1.

temperature and allow the temperature to rise gradually to the standard by stirring with a thermometer. When the oil in the tube *A* has reached the standard temperature, remove the thermometer and withdraw the oil from overflow *B* by means of a pipette.

The viscosity shall be expressed in terms of the number of seconds required for 60 cc. to flow out into the flask *F*, and shall be timed from the removal of the stopper *L*. Special care must be taken that the temperature of the bath *C* is kept constant during the entire outflow of the oil.

SPECIFIC GRAVITY.

The specific gravity shall be determined by the use of a Geissler pyknometer, standardized at 60° F. For fluid lubricants either the Westphal balance or the specific or Baumé hydrometer gives sufficiently accurate results.

For Baumé hydrometers, the committee recommends the use of those based on the formula of the Bureau of Standards:

$$\text{Specific Gravity} = \frac{140}{130 + \text{Be.}^\circ\ 60^\circ/60^\circ\ \text{F.}}$$

It should be understood, however, that many Baumé hydrometers now in use are not based on this formula, and, in converting the readings of any Baumé hydrometer to specific gravity, care should be taken to use the formula on which the instrument in question is based.

FREE ACID.

Place about 10 g. of oil in a 200-cc. Jena Erlenmeyer flask, add 60 cc. of neutral alcohol, warm the mixture to about 60° C., and titrate with N/6 KOH, free from CO_2, using phenolphthalein, the flask being frequently and thoroughly shaken.

The free acid, if present, shall be reported as the number of milligrams of KOH necessary to neutralize the acidity in 1 g. of oil, and the nature of the acid stated if possible.

CLOUD AND POUR TESTS.[1]

The oil, whether for cloud or pour test, shall first be heated to 150° F., and cooled down in air to about 75° F.

Cloud Test.—The cloud test indicates the point at which paraffin wax or other solid substances crystallize out or separate from solution in the oil.

Put the oil to be tested in a glass jar or bottle of approximately $1\frac{1}{4}$ in. inside diameter and 4 to 5 in. high, to a height of about $1\frac{1}{4}$ in. or sufficient to reach $\frac{1}{4}$ in. above the mercury bulb

[1] There is much confusion existing in regard to the terms "cold test," "chill test," "pour test," "flow test," "setting point," "solidifying point," etc., used in connection with lubricating oils. By "cold test" some understand to be meant what is more strictly defined as "cloud test," and others what is more strictly defined as "pour test." Still others use this term "cold test" to apply to both of these, they being considered sub-divisions of cold test. In view of the considerable use of the term "cold test" in the latter sense, and of the fact that all the tests named are made by application of cold to the oil tested, it seems best to adopt "cold test" as a generic term, and adopt as sub-heads "cloud test" and "pour test."

of the thermometer. The thermometer used is the so-called cold-test thermometer, which is specially made for this purpose and has a bulb of $\frac{1}{4}$ to $\frac{3}{8}$ in. long. Insert the thermometer through a tight fitting cork so that it is held centrally in the jar, with the lower end of the bulb $\frac{1}{2}$ in. from the bottom of the jar. Then place the cold-test jar in a metal or glass jacket 4 to 5 in. high, having inside diameter $\frac{1}{2}$ in. larger than the outside diameter of the test jar. A disk of felt, cork or wax, $\frac{1}{4}$ in. in thickness, is placed in the bottom of the jacket. Care should be taken that the test jar is placed in the center of the jacket, so that it does not touch the sides at any point. Then put the whole apparatus into the refrigerating mixture and at every drop in temperature of 2° F. when near the expected cloud test, remove the jar from the jacket and inspect, being careful not to disturb the oil by moving the thermometer or otherwise. When the lower half of the sample becomes opaque through chilling, read the thermometer. This reading shall be taken as the "cloud test" of the oil.

Pour Test.—The pour test indicates the temperature at which a sample of oil in cylindrical form of specified diameter and length will just flow under specified conditions.

In making this test the same bottle and quantity of oil are used as for the cloud test, and the pour test may, if desired, be taken after the cloud test has been determined; in the great majority of cases the cloud test being the higher. In making the pour test, place the jar containing the oil in a close-fitting metal jacket provided at the bottom with a disk of felt or cork $\frac{1}{4}$ in. thick. Place this in the freezing mixture. At each drop in temperature of 5° F. remove the bottle from the jacket and tilt it until the oil begins to flow—just sufficiently tilted but no more. In the extreme case, the bottle should be tilted to the horizontal. When the oil has become solid around the thermometer and will not flow, the previous 5° point shall be taken as the "pour test" of the oil. Preferably, the cold should be applied so that the pour test, will be completed in approximately one half-hour. The materials used in the freezing mixture may be ice, calcium chloride or sodium chloride, or solid carbon dioxide with acetone, depending upon the temperature desired in making the tests. For oils congealing or

solidifying above +35° F. pounded ice is used. From +35 to +15° F., a mixture of pounded ice and a small addition of salt, one to twenty by volume may be taken. For temperatures from +15 to −5° F., also use an ice and salt mixture adding about one-third salt. The salt should be very dry and granulated fine enough to pass through a 20-mesh sieve. From zero to −25° F., a mixture of ice and calcium chloride is used. For temperatures lower than −5° F., however, it will be found very convenient to use solid carbon dioxide and acetone, by which any desired temperature down to −70° F., can be obtained or even lower. This freezing mixture is made as follows:

Take a sufficient amount of dry acetone and put it into a covered metal beaker, copper or nickel; put the beaker into an ice-salt mixture and when the temperature of the acetone reaches +10° F., or below, add by degrees solid carbon dioxide, until the desired temperature is reached. To get the solid carbon dioxide, take an ordinary liquefied carbon-dioxide cylinder and invert it, open the valve carefully and let the gas run out into a chamois-skin bag. By the rapid evaporation the dioxide becomes solid.

APPENDIX.

CONVERSION TABLES FOR SAYBOLT UNIVERSAL, ENGLER, AND REDWOOD VISCOSIMETERS.

By C. W. Waidner.

A series of intercomparisons between the Saybolt Universal, Engler, and Redwood viscosimeters was made at the Bureau of Standards, for the purpose of furnishing suitable tables for converting results expressed on the viscosity scale of any one of these instruments to the corresponding results on the viscosity scale of either of the other instruments. There were included in these intercomparisons, two Saybolt Universal viscosimeters (Nos. 580 and 727) kindly loaned by Mr. George M. Saybolt, one Saybolt Universal viscosimeter (No. 765) kindly loaned by Dr. David T. Day, four Engler viscosimeters (Sommer and Runge, Berlin, Nos. 1402, 2204, 46–2, and 46–4) belonging to the Bureau of Standards, and 2 Redwood viscosimeters (Nos. 1004 and 1205) also belonging to the Bureau. The Engler viscosimeter, No. 1402, had been standardized at the Physikalisch-Technische Reichsanstalt.

So called viscosities are expressed on the scales of these instruments as follows:

With the Saybolt Universal viscosimeter the viscosity of an oil at any given temperature is expressed as the efflux time in seconds of 60 cc. of the oil at that temperature.

With the Engler instrument the viscosity of the oil at any given temperature is expressed as the quotient of the efflux time of 200 cc. of the oil at the given temperature by the efflux time of 200 cc. of water at 20° C. This quotient is called the Engler number of the oil at the temperature at which the efflux time was observed.

With the Redwood viscosimeter the viscosity of an oil at any given temperature is expressed as the efflux time in seconds of 50 cc. of the oil at that temperature.

Ten lubricating oils ranging in viscosities from that of light machinery to heavy cylinder oils were used in these intercomparisons, measurements being made at 70, 100, 130 and 210° F. In all, several hundred efflux times were determined with the several instruments above mentioned. In addition the efflux times were determined for water at 20° C.; for a sample of

TABLE I.—EXPERIMENTALLY DETERMINED RATIOS OF MEAN EFFLUX TIMES FOR FOUR ENGLER VISCOSIMETERS (MEAN WATER VALUE 51 SECONDS), TO THE MEAN EFFLUX TIMES FOR THREE SAYBOLT UNIVERSAL, AND TO THE MEAN EFFLUX TIMES FOR TWO REDWOOD VISCOSIMETERS.

Efflux Time for Engler, seconds.	Ratio of Engler Time to Saybolt Time.	Ratio of Engler Time to Redwood Time.
50	1.83	1.92
52	1.81	1.90
54	1.79	1.89
56	1.77	1.88
58	1.76	1.87
60	1.74	1.85
62	1.72	....
64	1.71	....
65	....	1.83
66	1.70	....
68	1.68	....
70	1.67	1.81
75	1.63	1.79
80	1.60	1.77
85	1.58	1.76
90	1.55	1.75
95	1.53	1.74
100	1.51	1.73
105	1.49	1.72
110	1.48	1.71
120	1.46	1.70
130	1.44	1.69
140	1.43	1.68
150	1.41	....
160	1.40	1.67
180	1.39	1.66
200	1.38	1.65
220	1.37	1.64
300	1.36	1.63
....	....	....
2500	1.36	1.63

kerosene at 70° F.; for a sample of olive oil at 70, 100, 130, and 210° F.; and for a sample of castor oil at 100, 130, and 210° F.

The final results of all these measurements are embodied in Table I, in which are given, for various efflux times of an Engler instrument having a "water value" of 51 seconds, the ratios of efflux times for this Engler instrument to the mean efflux times for the three Saybolt and the two Redwood viscosimeters included in these intercomparisons. The conversion

factors given in Table I were found to be applicable for all the oils tested and at all the temperatures at which the tests were made (70 to 210° F.), within the limits of accuracy that these instruments can be used in industrial viscosimetry. The conversion factors found for the Saybolt Universal and the Engler viscosimeters were found to depend only upon the time of efflux of the oil and not upon the temperature; that is, if two oils, one at high temperature, and the other at low temperature, showed approximately equal times of efflux with the Saybolt Universal instrument for example, the conversion factors found were practically identical. The variations in the dimensions of the viscosimeters, due to the thermal expansion over the range of temperature used in the experiments, is too small to appreciably affect the conversion factors, or even the times of efflux. The fact that these factors show no systematic variation with temperature therefore indicates that if the oil in the jet is not at the same temperature as the oil in the main portion of the viscosimeter, any effect due to this cause is the same for the two types of instruments.

The conversion factors found for the Redwood viscosimeter seemed on the other hand to depend not only upon the efflux times, but to some extent upon the temperature. For example, the ratio of Saybolt time to Redwood time (S/R) corresponding to a given efflux time was found to be usually somewhat greater when this efflux time had been observed at a low temperature, than when the same efflux time had been found with another oil at a higher temperature. An effect of this kind would be produced, if at the high temperatures the temperature of the oil in the agate jet of the Redwood viscosimeter were lower than the temperatures of the oil in the metal jet of the Saybolt Universal viscosimeter.

The conversion factors given in Table I are averages from all the observed data, the accuracy being such as not to warrant separate conversion tables for different temperatures. Convenient working tables (Tables II, III and IV) were obtained from the data of Table I by plotting these data and interpolating from the curves so obtained.

Attention should be called to the fact that any one making use of these conversion tables implicitly assumes that the vis-

cosity scale defined by any Saybolt Universal, Engler or Redwood viscosimeter is in agreement with the mean Saybolt, Engler or Redwood scale defined by the instruments that were used in these intercomparisons. This assumption is in general only approximately true, since very small variations in some of the dimensions of the instruments will cause very significant variations in the efflux times. No definite statement can be made as

TABLE II.—MULTIPLYING FACTORS TO REDUCE ENGLER NUMBERS TO SAYBOLT OR TO REDWOOD TIMES.

Engler Number.	Factor to Reduce Engler Number to Saybolt Time.	Factor to Reduce Engler Number to Redwood Time.
1.00	28.1	26.7
1.05	28.4	27.0
1.10	28.8	27.2
1.15	29.1	27.4
1.20	29.5	27.6
1.25	29.8	27.8
1.30	30.1	28.0
1.35	30.4	28.2
1.40	30.8	28.3
1.45	31.1	28.5
1.50	31.5	28.6
1.60	32.0	28.8
1.70	32.5	29.0
1.80	33.0	29.2
1.90	33.5	29.4
2.00	33.9	29.6
2.10	34.2	29.7
2.20	34.5	29.9
2.30	34.8	30.0
2.40	35.1	30.1
2.50	35.3	30.2
2.60	35.5	30.3
2.70	35.7	30.3
2.80	35.9	30.4
2.90	36.1	30.4
3.00	36.2	30.5
3.50	36.7	30.7
4.00	37.0	30.9
4.50	37.3	31.1
5.00	37.4	31.2
6.00	37.5	31.3
....	....	....
50.00	37.5	31.3

to how much different instruments of any one make may differ in results found with them, as this will obviously depend upon the accuracy with which the maker has made his instruments to conform to standard dimensions in all parts having an influence on the efflux times, or upon the care exercised by him in adjusting his instruments to make them agree with standard instruments. If the dimensions for any given instrument differ by any considerable amount from the dimensions of the standard instru-

ment, then adjustment of any one dimension to make the instrument give the same efflux time as the standard instrument for any one oil, will not necessarily result in making the adjusted instrument agree with the standard, when used with oils having very different efflux times.

The Engler instrument has been carefully standardized as to the dimensions of its several parts that have any effect

TABLE III.—MULTIPLYING FACTORS TO REDUCE SAYBOLT TIMES TO ENGLER NUMBERS OR TO REDWOOD TIMES.

Saybolt Time, seconds.	Factor to Reduce Saybolt Time to Engler Number.	Factor to Reduce Saybolt Time to Redwood Time.
28	0.0357	0.95
30	0.0352	0.95
32	0.0346	0.94
34	0.0342	0.94
36	0.0337	0.94
38	0.0334	0.93
40	0.0330	0.93
42	0.0327	0.92
44	0.0323	0.92
46	0.0320	0.91
48	0.0317	0.91
50	0.0314	0.90
55	0.0308	0.90
60	0.0302	0.89
65	0.0297	0.88
70	0.0293	0.87
75	0.0289	0.86
80	0.0286	0.86
85	0.0284	0.86
90	0.0282	0.85
95	0.0280	0.85
100	0.0279	0.85
110	0.0276	0.85
120	0.0274	0.84
130	0.0272	0.84
140	0.0271	0.84
160	0.0269	0.84
180	0.0268	0.84
200	0.0267	0.84
....	.....	....
1800	0.0267	0.84

on the efflux times. Also the permissible variations in the dimensions of these parts have been specified. It is not possible for the instrument maker to construct an instrument having the exact dimensions specified, so small variations not exceeding specified limits are permitted. By accurately measuring the dimensions of the several parts of any instrument, the variation from standard dimensions may be found and suitable corrections can then be applied to the results found with the instrument, thus giving results that would have been found with a perfect

Engler instrument, that is, one conforming exactly to the specified dimensions. The effect of small variations in the dimensions of the Engler instrument from standard dimensions has been investigated by Dr. W. Meissner.[1]

The efflux time of 200 cc. of water at 20° C. for the Engler viscosimeter must be between 50 and 52 seconds according to the standard specifications, being practically 51 seconds (50.94 seconds, according to Meissner[2]), if the dimensions are exactly those specified. For the four Engler viscosimeters used in the Bureau of Standards intercomparisons, the mean of the efflux times of 200 cc. of water at 20° C. was 51.0 seconds; the individual times being 50.5, 51.7, 51.1, and 50.9 seconds.

All of the oils were tested in each of the four Engler instruments. The average of the four Engler numbers at any given temperature was taken as the Engler number of the oil at that temperature. The average difference between the results found with the four instruments was as follows:

Engler Instrument No.	Percentage by which the observed Engler number must be corrected to reduce to the mean Engler number found with all four instruments.	Percentage by which the observed Engler efflux times must be corrected to reduce to the mean Engler efflux times found with all four instruments.
1402	+0.9	+1.9
2204	−0.8	−2.1
46-2	+0.6	+0.5
46-4	−0.6	−0.3

It will be seen that on the average for all the oils, two of the instruments differed by as much as 1.7 per cent in the Engler numbers found with them, instrument No. 1402 giving Engler numbers about 0.9 per cent lower and instrument No. 2204 about 0.8 per cent higher than the mean Engler number found with the four instruments. The Engler numbers observed with the different instruments differ less, as is to be expected, than the efflux times observed with the different instruments. Thus the

[1] "Ueber den Einfluss fehlerhafter Abmessungen auf die Angaben des Engler'schen Zähigkeitsmessers" *Chemische Revue über die Fette und Harz-Industrie*, Vol. 17, pp. 202–209 (1910).

[2] *Loc. cit.*

efflux times observed with instrument No. 1402 differed by about 4 per cent from the efflux times observed with instrument No. 2204.

Approximate dimensions of the several parts of the Saybolt Universal viscosimeter have been published by Gill,[1] and are also given in the Proceedings of this Society.[2] The more important dimensions of the Saybolt Universal viscosimeter No. 752 have been published by Meissner.[3]

TABLE IV.—MULTIPLYING FACTORS TO REDUCE REDWOOD TIMES TO SAYBOLT TIMES OR TO ENGLER NUMBERS.

Redwood Time, seconds.	Factor to Reduce Redwood Time to Saybolt Time.	Factor to Reduce Redwood Time to Engler Number.
26	1.05	0.0377
28	1.05	0.0372
30	1.06	0.0368
32	1.06	0.0364
34	1.07	0.0361
36	1.07	0.0358
38	1.08	0.0355
40	1.09	0.0353
42	1.10	0.0351
44	1.10	0.0349
46	1.11	0.0347
48	1.12	0.0345
50	1.13	0.0344
55	1.14	0.0340
60	1.15	0.0337
65	1.16	0.0335
70	1.16	0.0333
75	1.17	0.0331
80	1.18	0.0330
85	1.18	0.0329
90	1.18	0.0328
95	1.19	0.0327
100	1.19	0.0326
110	1.19	0.0325
120	1.20	0.0324
130	1.20	0.0322
140	1.20	0.0321
160	1.20	0.0321
180	1.20	0.0320
.....	.....	.....
1500	1.20	0.0320

The essential dimensions of three Saybolt instruments used in the present intercomparisons have been accurately measured as a preliminary to further work on the standardization of dimensions of this instrument. Inasmuch as the Saybolt Universal viscosimeters have in the past all been adjusted by the maker, by slight modifications in their dimensions to agree with the

[1] "Oil Analysis," 7th edition, revised, p. 29.

[2] Vol. XIV, Part I, p. 358.

[3] *Chemische Revue über die Fette und Harz-Industrie*, Vol. 19, p. 9 (1912).

Saybolt standards, it was deemed necessary to make a direct comparison between the Saybolt standard instruments, and an instrument made up to have the mean dimensions, in its several parts, of these three instruments (Nos. 580, 727, 765). Negotiations have been entered into to make such an intercomparison, before attempting final standardization of the dimensions of the Saybolt Universal viscosimeter.

The efflux times of 60 cc. of water at 20° C. for the three Saybolt Universal viscosimeters were 28.5, 28.4 and 27.6 seconds; averaging 28.2 seconds. The efflux time for water at 20° C. was found by Meissner to be 28.55 seconds for the Saybolt Universal viscosimeter No. 752. The average of the efflux times found with the three Saybolt instruments for each oil at any given temperature was taken as the Saybolt time of the oil at that temperature. The average difference between the results found with the three instruments was as follows:

Saybolt Instrument No.	Percentage by which observed Saybolt number[1] must be corrected to reduce to the mean Saybolt number found with all three instruments.	Percentage by which the observed Saybolt efflux times must be corrected to reduce to the mean Saybolt efflux times found with all three instruments.
580	−0.9	−2.0
727	+0.6	−0.2
765	+0.2	+2.2

[1] The Saybolt number would be the observed efflux time divided by the efflux time of 60 cc. of water at 20° C. (68° F.). It is quite general practice to use efflux times with the Saybolt instrument, instead of Saybolt numbers.

It will be seen that on the average for all the oils, two of the instruments differed by as much as 4.2 per cent in the efflux times found with them. If Saybolt numbers had been used in the same manner as Engler numbers are used, instead of the efflux times, the greatest difference between any two of the instruments would on the average for all the oils have been only about 1.5 per cent.

The approximate dimensions of the several parts of the Redwood viscosimeter have been published by Redwood.[1]

[1] "Petroleum and its Products," Vol. 11, 2d edition, pp. 600–602.

The more important dimensions of Redwood viscosimeter No. 1263 have been published by Meissner.[1]

The efflux times of 50 cc. of water at 20° C. (68° F.) for the two Redwood viscosimeters were 26.7 and 27.2 seconds. The efflux time for water at 20° C. was found by Meissner to be 26.5 seconds for Redwood viscosimeter No. 1263. The average of the efflux times found with the two Redwood instruments for each oil at any given temperature was taken as the Redwood time of the oil at that temperature. On the average for all the oils, the efflux times found with the two Redwood instruments differed by 1.8 per cent, No. 1205 giving the longer efflux times. If Redwood numbers had been used in the same manner as Engler numbers are used, instead of the efflux times, the two instruments would have been in agreement on the average for all the oils.

Accuracy.—It may be possible with any single instrument to obtain consistent results to within 1 per cent. This does not mean, however, that industrial instruments can be depended upon for an accuracy of 1 per cent. Indeed, an accuracy of 1 per cent is higher than one should expect in an industrial test of the viscosity, or so-called viscosity, of an oil, when one considers the effect of small variations in dimensions on the efflux times observed with industrial viscosimeters. Thus a difference of only 0.01 mm. (0.0004 in.) in the mean diameter of the efflux tubes of the Saybolt Universal, Engler and Redwood viscosimeters may cause differences in the efflux times as great as 2.2, 1.4 and 2.5 per cent, respectively. Similarly, a difference of 0.1 mm. (0.004 in.) in the length of the efflux tubes of these instruments may cause differences in the efflux times as great as 0.7, 0.5 and 1 per cent, respectively. Differences of several per cent between different instruments of the same type are therefore not excessive.

It is very common to find oils, the viscosity of which changes by 3 per cent or more per 1° F. temperature change. Taking into consideration the fact that the temperature of the oil in these viscosimeters cannot be accurately controlled and may not be uniform throughout, it is seen that an accuracy of 1 per cent in the determination of the efflux time of such an oil would require

[1] "*Chemische Revue über die Fette und Harz-Industrie*," Vol. 19, p. 9 (1912).

precautions in temperature control and measurements such as are not practicable in industrial tests.

Absolute Viscosities.—It should be remembered that the viscosity scales of all industrial viscosimeters using the efflux principle are purely arbitrary scales, that is, whether the results are expressed as efflux times or numbers (for example, efflux time of oil ÷ efflux time of water at 20° C.), these efflux times or numbers may be far from being proportional to the true viscosities of the oils.

All the efflux viscosimeters in use to-day have efflux tubes, the diameters of which are so large and lengths so small that a large proportion of the energy of flow—at least for liquids of low viscosity—is carried off in the issuing stream of the liquid. For example, with the Engler viscosimeter the energy used in overcoming viscous resistance within the efflux tube, when water is used in the instrument, is only about one-seventh of the energy of flow imparted to the water; while with a viscous lubricating oil, for example, an engine oil at room temperature, 95 per cent or more of the energy of flow is used up in overcoming viscous resistance, so that the correction for energy of flow is small.

For the reason thus briefly stated, it is evident why the Engler numbers of oils of quite different viscosities are far from being proportional to the absolute viscosities of the oils. For example, consider oils having the Engler numbers and corresponding absolute viscosities as follows:[1]

Engler No.	Absolute Viscosity, dynes per sq. cm.
1	0.01006 × specific gravity
2	0.1148 × " "
5	0.353 × " "
10	0.726 × " "
20	1.46 × " "
30	2.19 × " "
60	4.38 × " "

It will be seen that an oil with an Engler Number of 60 (for example, a heavy cylinder oil tested at 50° C.) has a viscosity not 60 times that of water (for which the Engler Number = 1), but

[1] From *Tabellen zum Englerschen Viskosimeter*, by Dr. Leo Ubbelohde.

$$\frac{4.38 \times (\text{sp. gr. of oil at } 50^\circ \text{ C.})}{0.01006 \times (\text{sp. gr. of water at } 20^\circ \text{ C.})} = 435 \left(\frac{\text{sp. gr. of oil at } 50^\circ \text{ C.}}{\text{sp. gr. of water at } 20^\circ \text{ C.}} \right)$$

times the viscosity of water at 20° C. On the other hand for oils for which the Engler numbers are 5 or over, these numbers are quite nearly proportional to the absolute viscosities.

In the same way it may be shown that the efflux times observed with the Saybolt Universal and with the Redwood viscosimeters are far from being proportional to the viscosities of the oils, although, as in the case of the Engler viscosimeter, for the viscous oils the times of efflux vary in approximately the same ratio as do the viscosities of the oils.

Where it is desired to express viscosities in absolute units, the results found may be converted to the scale of the Engler viscosimeter and the Engler numbers thus found may be converted to absolute units by means of Ubbelohde's tables. The accuracy of such a procedure is sufficient for every requirement of the industrial testing of oil.

DISCUSSION.

MR. HENRY F. MUER (*presented in written form*).—In the proposed Standard Tests for Lubricants, the committee recommends the use of neutral alcohol in determining free acid. We (Mount Prospect Laboratory, City of New York) find it more satisfactory to make a blank test of the alcohol rather than use strictly "neutral" alcohol. **Mr. Muer.**

In regard to the "Pour" test, I believe it would be proper to heat the oil a reasonable time in advance of making this test, if the oil is a compounded one. In the case of cylinder oils, we always heat the oil before withdrawing portions for the other tests, since we thus obtain much more concordant results. It is possible that some of the fatty oil may separate out on standing, especially if the oil is exposed to low temperature during storage.

MR. G. B. UPTON (*presented in written form*).—The publication of conversion tables for the Saybolt, Redwood and Engler viscosimeters, from intercomparisons made at the Bureau of Standards, marks a great step in advance in commercial viscosimetry in this country. Measurements made with one instrument need no longer be meaningless to those accustomed to other instruments. Yet it seems that the reform goes but half as far as it might. The ultimate goal is the statement of viscosity measurements in absolute units. Progress in engineering testing is always from empirical units to the absolute units of physical or chemical science. If it can be shown that the absolute units of viscosity can be readily computed from the measurements of any of the common viscosimeters, it may be that our Society will complete the work it has already begun in standardization of viscosity measurements, by requiring the statements of results in absolute units, which are independent of the particular type of viscosimeter employed. **Mr. Upton.**

A flow viscosimeter does not measure viscosity. It measures the ratio of viscosity to density, at atmospheric pressure, and at the temperature which the fluid possesses as it approaches

Mr. Upton. and runs through the discharge tube of the viscosimeter. The general form of the equation, connecting the ratio of viscosity to density with the time of flow of a set quantity of fluid from a given viscosimeter, may be readily developed.

The initial head, from the surface of the liquid in the bowl of the viscosimeter to the bottom of the discharge tube, is a set quantity in each instrument. The quantity discharged being

TABLE I.—RELATION BETWEEN ENGLER NUMBER AND $\frac{n}{d}$.

Engler Number, e.	$\frac{n}{d}$, absolute c. g. s. units.	$\frac{n}{de}$	$\frac{1}{e^2}$
1	0.01006	0.01006	1.00
2	0.1148	0.0574	0.25
5	0.353	0.0706	0.04
10	0.726	0.0726	0.01
20	1.46	0.0730	0.0025
30	2.19	0.0730	0.00111
60	4.38	0.0730	0.00028

TABLE II.—COMPARISON OF $\frac{n}{d}$ FROM BUREAU OF STANDARDS DATA AND THEORETICAL EQUATION.

Engler Number, e	$\frac{n}{d}$, Bureau of Standards.	$\frac{n}{d}$, from equation $\left(0.0730\ e - \frac{0.06294}{e}\right)$
1	0.01006	0.01006
2	0.1148	0.1145
3	.....	0.1980
4	.....	0.2763
5	0.353	0.3524
6	.....	0.4275
10	0.726	0.724
20	1.46	1.457
30	2.19	2.188
60	4.38	4.379

fixed, the drop of head during the run is also fixed. Hence the average head causing flow is a fixed quantity.

The average available total head h is used up in two ways; in the viscous resistance to flow approaching and passing through the discharge tube, and in kinetic energy of the discharging stream of fluid. The head used in viscous resistance, h_1, is proportional to the product of viscosity of the fluid and velocity of flow. Putting Q for quantity (volume) of fluid

drawn out during a run, t for the time of the run and n for absolute viscosity, d for density of fluid, and α a constant, Mr. Upton.

$$h_1 = \alpha\, n \frac{Q}{dt}.$$

The head used in kinetic energy of discharge, h_2, is a "velocity head" of a peculiar kind. Putting β for a second constant,

$$h_2 = \beta \frac{Q^2}{t^2}.$$

The total head h is the sum of h_1 and h_2. Hence

$$h \text{ (a fixed quantity)} = \alpha\, n \frac{Q}{dt} + \beta \frac{Q^2}{t^2}.$$

Solving for $\frac{n}{d}$, which the viscosimeter measures, we get the general equation of the flow viscosimeter:

$$\frac{n}{d} = \frac{h\,t}{\alpha\, Q} - \frac{\beta\, Q}{\alpha\, t}$$

or, with A for $\frac{h}{\alpha\, Q}$ and B for $\frac{\beta\, Q}{\alpha}$,

$$\frac{n}{d} = A\,t - \frac{B}{t}.$$

For a given viscosimeter, running with fixed Q, or volume drawn off, A and B are instrument constants readily found.

To calibrate a viscosimeter one needs two or more liquids of known values of $\frac{n}{d}$. Dividing the viscosimeter equation through by t gives

$$\left(\frac{n}{dt}\right) = A - B\left(\frac{1}{t^2}\right).$$

Plotting $\frac{n}{dt}$ as ordinate against $\frac{1}{t^2}$ as abscissa gives a straight

Mr. Upton. line, of which the intercept on the $\frac{n}{dt}$ axis at $\frac{1}{t^2} = 0$ is A, and the slope of the line is B. Distilled water may be one of the standard liquids used; others of considerably higher viscosity are

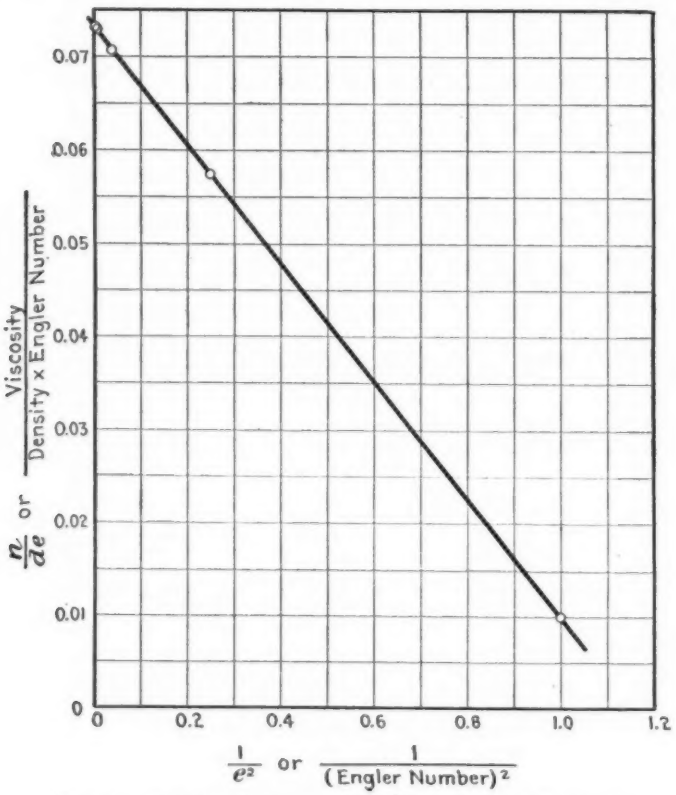


FIG. 1.—Relation between Engler Number and Ratio of $\frac{\text{Viscosity}}{\text{Density}}$ of Liquid: $\frac{n}{d} = 0.0730\,e - \frac{0.06294}{e}$.

needed. The suggestion is ventured that, if the scheme of viscosimeter calibration here proposed is adopted, the U. S. Bureau of Standards be asked to send out some pure mineral oils for such calibration use, with known $\frac{n}{d}$ vs. temperature curves or tables for the region of ordinary temperatures.

To show the competence of the viscosimeter equation pro- Mr. Upton.
posed, namely,

$$\frac{n}{d} = A\,t - \frac{B}{t},$$

to compute the ratio of viscosity to density from observations on any of the common flow viscosimeters, data have been taken from the Appendix to Report of Committee D-2, entitled "Conversion

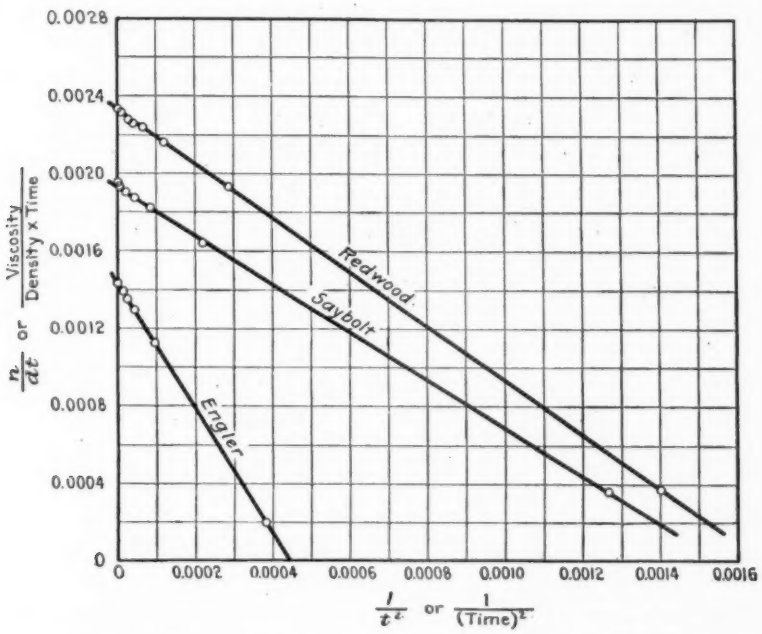


FIG. 2.—Calibration Curves of Average Examples of Viscosimeters (from Data of the Bureau of Standards).

Tables for Saybolt Universal, Engler, and Redwood Viscosimeters." The data are shown in Tables I and II, and plotted as calibration curves in Figs. 1 and 2. Table I shows the data for the relation between Engler number and the ratio of absolute viscosity to density in c. g. s. units. The plot of $\frac{n}{de}$ vs. $\frac{1}{e^2}$, in

Mr. Upton. Fig. 1, shows that all the points fall on a straight line, with intercept 0.0730 and slope 0.06294. The relation between the $\frac{n}{d}$ ratio and Engler number e is accordingly

$$\frac{n}{d} = 0.0730\, e - \frac{0.06294}{e}.$$

Table II shows the accuracy of this equation, or perhaps, since the equation is theoretically correct, the accuracy of the data from the Bureau of Standards.

Table III gives the data for the Saybolt viscosimeter calibration curve in Fig. 2. Table IV gives similar data for the Redwood, and Table V for the Engler. Engler time is taken as 51.0 times Engler number; the Saybolt and Redwood times are computed from the Engler numbers by the conversion factors of the Waidner conversion tables.

The calibration curves of Fig. 2 are plotted from the data of Tables III, IV and V. The calibration equations are:

$$\textit{Saybolt:} \quad \frac{n}{d} = 0.001930\, t - \frac{1.242}{t}$$

$$\textit{Redwood:} \quad \frac{n}{d} = 0.002322\, t - \frac{1.387}{t}$$

$$\textit{Engler:} \quad \frac{n}{d} = 0.001432\, t - \frac{3.216}{t}$$

It would scarcely be safe to use these calibration equations as true for all viscosimeters of the Saybolt, Redwood, or Engler types. Viscosimeters are so extremely sensitive to changes of their dimensions that the constants A and B of the general equation type $\frac{n}{d} = A\, t - \frac{B}{t}$ really ought to be found for each individual instrument, for its special method of operation. The running of two or more liquids of known values of $\frac{n}{d}$ will suffice to determine the constants of any viscosimeter once for all.

I hope I have made it clear that absolute viscosities can readily be found from any of the commercial viscosimeters by establishing their constants in the general equation of the Mr. Upton.

TABLE III.—CALIBRATION DATA FOR SAYBOLT VISCOSIMETER.

Engler Number.	Conversion Factor to Saybolt Time.	Saybolt Time, t, seconds.	$\frac{n}{d}$	$\frac{n}{dt}$	$\frac{1}{t^2}$
1	28.1	28.1	0.01006	0.000358	0.001266
2	33.9	67.8	0.1145	0.001678	0.0002176
3	36.2	108.6	0.1980	0.001823	0.0000849
4	37.0	148.0	0.2763	0.001868	0.0000457
5	37.4	187.0	0.3524	0.001885	0.0000286
6	37.5	225.0	0.4275	0.001899	0.0000198
10	37.5	375.0	0.724	0.001932	0.00000711
20	37.5	750.0	1.457	0.001942	0.00000178
30	37.5	1125.0	2.188	0.001946	0.00000079
60	37.5	2250.0	4.379	0.001946	0.00000020

TABLE IV.—CALIBRATION DATA FOR REDWOOD VISCOSIMETER.

Engler Number.	Conversion Factor to Redwood Time.	Redwood Time, t, seconds.	$\frac{n}{d}$	$\frac{n}{dt}$	$\frac{1}{t^2}$
1	26.7	26.7	0.01006	0.000377	0.001402
2	29.6	59.2	0.1145	0.001934	0.000285
3	30.5	91.5	0.1980	0.002163	0.0001195
4	30.9	123.6	0.2763	0.002235	0.0000654
5	31.2	156.0	0.3524	0.002257	0.0000411
6	31.3	187.8	0.4275	0.002276	0.0000284
10	31.3	313.0	0.724	0.002314	0.0000102
20	31.3	626.0	1.457	0.002327	0.00000255
30	31.3	939.0	2.188	0.002330	0.00000113
60	31.3	1878.0	4.379	0.002330	0.00000028

TABLE V.—CALIBRATION DATA FOR ENGLER VISCOSIMETER.

Engler Number.	Engler Time, t, seconds.	$\frac{n}{d}$	$\frac{n}{dt}$	$\frac{1}{t^2}$
1	51.0	0.01006	0.000197	0.000384
2	102.0	0.1145	0.001122	0.0000961
3	153.0	0.1980	0.001295	0.0000427
4	204.0	0.2763	0.001355	0.0000240
5	255.0	0.3524	0.001383	0.0000154
6	306.0	0.4275	0.001398	0.0000107
10	510.0	0.724	0.001422	0.00000384
20	1020.0	1.457	0.001428	0.00000096
30	1530.0	2.188	0.001431	0.000000427
60	3060.0	4.379	0.001432	0.000000107

type given. The desirability of stating viscosity data in absolute units, instead of the empirical ones, would seem self-evident.

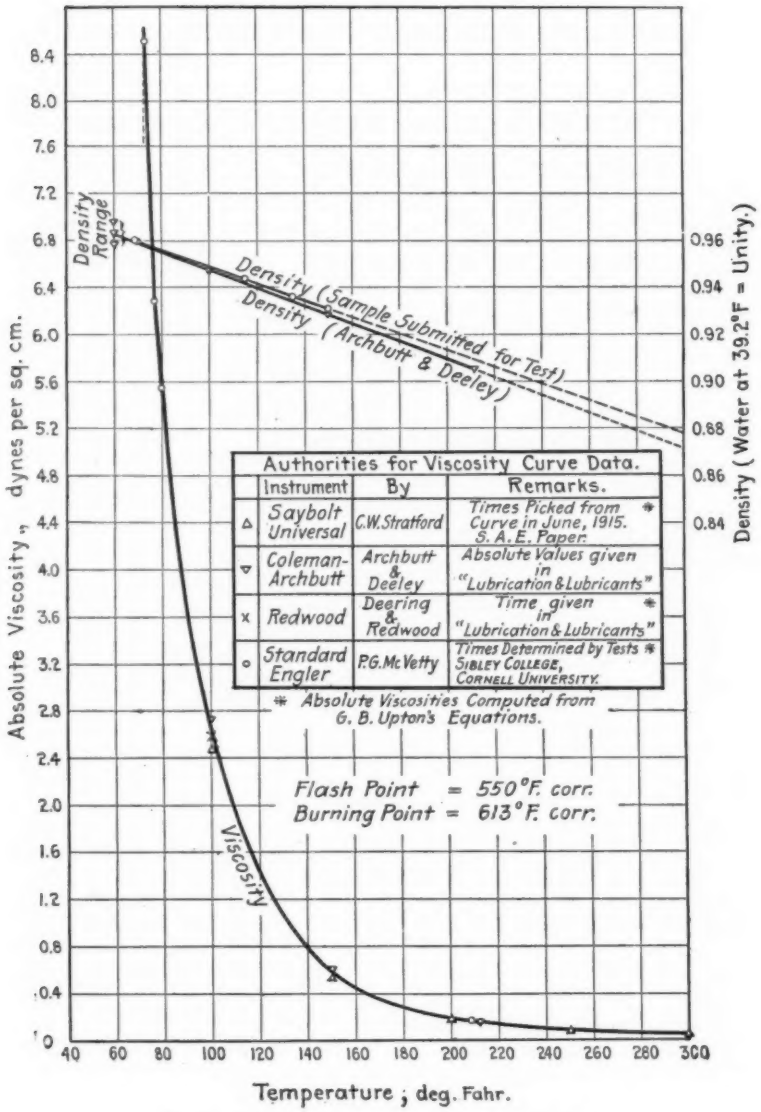

Absolute Viscosity, dynes per sq. cm.
Density (Water at 39.2°F = Unity.)
Temperature; deg. Fahr.
Density Range
Density (Sample Submitted for Test)
Density (Archbutt & Deeley)
Viscosity
Authorities for Viscosity Curve Data.
Instrument | By | Remarks.
△ Saybolt Universal | C.W. Stratford | Times Picked from Curve in June, 1915. S.A.E. Paper. *
▽ Coleman-Archbutt | Archbutt & Deeley | Absolute Values given in "Lubrication & Lubricants"
× Redwood | Deering & Redwood | Time given in "Lubrication & Lubricants" *
○ Standard Engler | P.G. McVetty | Times Determined by Tests * Sibley College, Cornell University.
* Absolute Viscosities Computed from G. B. Upton's Equations.
Flash Point = 550°F. corr.
Burning Point = 613°F. corr.

FIG. 3.—Physical Properties of Castor Oil.

(*Addendum by letter.*)—We recently had occasion to run the viscosity temperature curve of castor oil in our laboratories, using an Engler viscosimeter. To check our work we took available data from three other sources, each on a different viscosimeter, with different observers, and different place and time of work. By means of the equations given above, all the observations were reduced to absolute viscosities, and are plotted in Fig. 3. All the points fall on a common curve very satisfactorily, which seems to demonstrate both the accuracy of the original observations concerned and the method of calculation. Mr. Upton.

MR. W. O. DUNBAR.—The intent of the minority report is, I presume, clear to those who have read it. It seems to me inadvisable for this Society to adopt, or to name so prominently in its methods, any specific make of instrument in any case. The important thing appears to be to point out in each case the essentials of a good and suitable instrument (the most important of all being the correctness of the results which it should give, the limits of error allowable, etc.) and also ways and means of standardization of such instruments. In the subject of viscosity of oils, Mr. Waidner's report on "Conversion Tables for Saybolt Universal, Engler and Redwood Viscosimeters," appended to the report of the committee, is as good an example as could be desired, showing the way to accomplish this purpose for one of the two classes of instruments in question. Instead of recommending the adoption of any one of these instruments as the only standard of the Society, his paper really points to the adoption of the ideal scale of absolute viscosity, which scale, by means of such tables, becomes theoretically and practically common ground for comparison of results of all meritorious instruments of this class. I think the principle illustrated by Mr. Waidner's report applies not only to viscosimeters, but to other instruments. Mr. Dunbar.

The foregoing covers briefly the main point I have to make, but I think it is a serious matter which should be brought before the Society very clearly. The other points I have raised as to the incompleteness of the report are minor ones. As to the cold test, it seems to me that Mr. Conradson, in his minority report, is perfectly right. I have signed it for that reason, and because the proposed cold test, as it stands in the majority report, is really an old method which twenty years ago was referred to as

Mr. Dunbar. one formerly used, and which was then not given preference for apparently very good reasons which still hold good.

Mr. Mackenzie. MR. K. G. MACKENZIE (*Secretary of Committee D-2*).—Since the Committee is presenting a report which is somewhat similar to that which was returned to it last year, an explanation is undoubtedly in order. Last year the report was referred on the strength of the minority report, signed by three members, because the Engler viscosimeter was not made an alternate standard. In support of the Engler, it was stated that it was adopted by the International Association for Testing Materials and had already been adopted by the United States Government in its various departments, and that it was the only instrument which had been standardized. A perusal of the proceedings of the International Association shows that the adoption of the Engler by the Association was not true to fact and that the Engler had not even been presented to the Association for adoption. As far as official government adoption is concerned, I know of no such official adoption of the Engler instrument by any department using lubricants. To be sure, certain specifications from a certain department may call for viscosity in terms of the Engler instrument, but this could hardly be called adoption, any more than the fact that the various government departments call for the use of three or four flash-point testers could be said to prove that all of these flash-point testers had been officially adopted by those departments. On the other hand, the Saybolt Universal Viscosimeter has been officially adopted by that government department which uses probably the largest amount of lubricants, namely the Navy Department. The only obstacle which therefore apparently remained was the standardization of the Saybolt instrument, and through the kindness of Mr. Waidner of the Bureau of Standards the committee is able to present this year standard dimensions. Mr. Waidner's investigations have also proved conclusively that the Saybolt Universal Viscosimeter is, at least, as accurate as either the Redwood or the Engler instruments, which are most widely used abroad.

A further objection was raised last year, by one of the signers of the minority report, that those using the Engler instrument should not be compelled to abandon this instrument in favor

of the Saybolt. Accordingly the committee, again through the kindness of Mr. Waidner, is presenting conversion tables for converting readings on the Engler and Redwood instruments into terms of the Saybolt. Since, moreover, there may be someone who desires readings in terms of absolute viscosity, and since tables have already been prepared for converting the Engler readings into absolute ones, the committee is also submitting tables for converting Redwood and Saybolt into Engler. The committee believed that by such a course all the objections raised last year would be removed, and indeed, the representative of the Bureau of Standards who last year signed the minority report has this year voted in the affirmative for the whole committee report. Mr. Mackenzie.

The minority report this year is, however, somewhat different from that of last year. The present objection to the Saybolt instrument is not because the Engler is not included as the alternate, but because the name "Saybolt" will receive the stamp of approval of the Society and may give preference to the particular makers of this instrument. That such a course should not be regarded as inconsistent with the fixed principles of the American Society for Testing Materials is shown by the fact that the Engler instrument made by one firm in Germany has not only been officially adopted by the German government, but has also been approved by the German Verbund für die Materialprüfungen der Technik, and is being strongly urged by the German members of the International Association for adoption. The Redwood instrument, moreover, which is controlled by Sir Boverton Redwood, is not only the official instrument of the British government, but likewise is being urged by the English members of the International Association. Therefore, the adoption of the Standard Saybolt Universal Viscosimeter, which holds in this country the same position the Engler and Redwood instruments hold in Germany and Great Britain respectively, would seem to be most proper.

MR. P. H. WALKER.—In regard to the objection raised in Mr. Dunbar's minority report to the method for specific gravity recommended by the committee, I should like to ask, as a matter of information, if it would be satisfactory to all parties concerned, to insert after the word "pyknometer," the phrase "or any other Mr. Walker.

Mr. Walker. equally accurate instrument," making it read, "The specific gravity shall be determined by the use of a Geissler pyknometer, or any other equally accurate instrument, standardized at 60° F." It seems to me that that amendment would be proper, and that it would answer every purpose.

Mr. Flowers. MR. ALAN E. FLOWERS.—Mr. Waidner's report is deserving, it seems to me, of a considerable amount of attention. Perhaps no better evidence could be obtained of the desirability of further work upon this subject than that presented by the committee itself in this report by Mr. Waidner. May I call attention to the following points? In Table I, given for the comparison of the different instruments in terms of relative factors, it is noteworthy that the ratio of times for the Saybolt and the Engler instrument shows a variation from 1.83 for the low viscosity materials to 1.36 for the denser materials. A similar variation occurs in the same table in the comparison between the Engler and the Redwood instruments. No better evidence could be adduced to show that none of the instruments are measuring real viscosity. The mere fact that over a thousand tests were necessary for intercomparison of these instruments is sufficient evidence of itself. If instruments were used that were measuring real viscosity, a single set of measurements would have answered the purpose. In regard to the force required for accelerating the fluid, it should be pointed out that the effect of that element must vary with the specific gravity of the material used, and no evidence is given in this table as to the values of the specific gravity of the materials intercompared. In the outflow time effects there is a critical velocity, and if the materials exceed that critical velocity there is a sudden change in the conversion factor. The point of that change will vary with the absolute density, so that these tables, good as they are, are still not sufficient. On the fourth page, we find the following: "No definite statement can be made as to how much different instruments of any one make may differ in results found with them." From the results of these tests, attention is called to a variation of 4 per cent in instruments from the same manufacturer. And further, on the next page, the statement is made that the "adjustment of any one dimension to make the instrument give the same efflux time as the

standard instrument for any one oil, will not necessarily result in making the adjusted instrument agree with the standard, when used with oils having very different efflux times." On the eighth page occurs the statement that negotiations have been entered into to make such an intercomparison between the different effects of variables before attempting a final standardization of the dimensions of the Saybolt Universal Viscosimeter. On the next page the statement is made that variations of viscosity of 3 per cent or more per degree Fahrenheit, which would correspond to between 5 and 6 per cent variation per degree Centigrade, may occur as the effect of temperature upon viscosity. I should like to add to this that the ordinary bearing oils will vary from 10 to 13 per cent per degree Centigrade, at room temperature, and the very heavy cylinder oils much more. One cylinder oil tested varied about 70 per cent per degree Centigrade. **Mr. Flowers.**

Now, further in regard to the use of any of the present flow-type instruments, attention might be called to the table on the tenth page showing the relations between Engler numbers and absolute viscosity, and in a paragraph on the same page, the statement that the energy of the flow in these instruments, used up in overcoming viscous resistance, varies between 14 and 95 per cent. Now no one of us would think of using a variable measuring scale, and yet that is what we are proposing to do if we propose to adopt as a standard any one of the present flow-type instruments. The conditions would not be so bad if we were measuring materials very viscous or always under the same conditions, but we are frequently called upon to measure the viscosity at a number of different temperatures and hence through a wide range.

MR. M. E. MCDONNELL.—In support of the statements of the previous speaker, it might be said that the evidence in the reports of the committee and of Mr. Waidner give the best of reasons for referring the whole matter back to the committee. **Mr. McDonnell.**

On the first page of the committee report we read, "there are many who for years past have used other instruments than the Saybolt and will probably continue to do so." In another statement on the same page of the report it is stated that "The Saybolt viscosimeter is the instrument in practically universal

Mr. McDonnell. use in the United States." It can, therefore, be seen that the report is inconsistent.

Referring to the report of Mr. Waidner, which is a very excellent one in so far as it goes, you will see that the Saybolt instrument has not been completely standardized. On the eighth page of this report we read, "Negotiations have been entered into to make such an intercomparison, before attempting final standardization of the dimensions of the Saybolt Universal viscosimeter." On the next page of this report, in discussing errors caused by variations in the dimensions of various parts of instruments, it is shown that a variation of 0.01 mm. in the mean diameter of the efflux tube, or a difference of 0.1 mm. in the length of this tube, causes a greater inaccuracy with the Saybolt instrument than with certain other viscosimeters. Coming to the last page of Mr. Waidner's report you will see that, with a certain viscosimeter, data have been completed which it is stated will enable any one to refer to a table and obtain the absolute viscosity of an oil. The paper does not show that it is possible to do this with the results of the Saybolt instrument without converting the results to those of another instrument which has been standardized. The readings of the Saybolt viscosimeter are purely arbitrary. They are understood by a few local consumers and producers, but it would be a mistake to adopt an instrument in which the scale is arbitrary, which has not been completely standardized and for which data are not available for directly obtaining the absolute viscosity which would be comprehended by scientists of other countries, regardless of their local environment. It would, therefore, be a mistake not to refer the entire matter back to the committee.

Mr. Herschel. MR. W. H. HERSCHEL.—I want to correct one statement of the last speaker in regard to the impossibility of obtaining absolute viscosity from the Saybolt instrument. It is perfectly evident that if you can convert readings of the Saybolt instrument into readings of the Engler, you have a means of getting absolute viscosity. Therefore, I maintain that readings of the Saybolt instrument are something perfectly definite and tangible and in no wise to be likened to measurements with an elastic band. We have conversion factors from the Saybolt into the Engler instrument from Mr. Waidner's table, and we have means

of conversion from the Engler into absolute units by Ubbelohde's tables. It is perfectly easy to get an equation for converting directly from the Saybolt into absolute units without taking the two steps I have mentioned. I believe, from the extracts from Mr. Upton's discussion, read by the Secretary, that he has in mind something of this kind. I have myself made investigations along these lines and I have found that by taking two values only from Table I of Mr. Waidner's report, that is, the relative water rates of the Engler and Saybolt instruments, and the value of 1.36 as the relative times of the two, for a very thick viscous oil, the whole range of values in the second column of the table can be calculated within 2 per cent. Therefore I believe that that is a satisfactory check on the theory and on the values in the table. **Mr. Herschel.**

MR. P. H. CONRADSON (*Vice-Chairman of Committee D-2*).— Mr. Chairman, the point I want to discuss here has already been taken up by the preceding speakers. However, I should like to say a few words in regard to the instruments used in testing the viscosity. We have to consider the real object of making this test of lubricating oils. Viscosity is only one of the many tests lubricating oils are and may be subjected to. They are only relative; none of them are absolute. If viscosity were a measure of the real lubricating value of an oil, it certainly would be worth while to spend a year or more in developing an instrument that would give absolute values. The three instruments, mentioned in the committee report, which have been discussed here, are equally good in many respects. One instrument, however, requires a much longer time for making the tests. Therefore, where many oils have to be tested daily, if an instrument is used that takes much longer time for temperature adjustments and other corrections, one cannot accomplish much, so that it is important in my opinion to select an instrument, other things being equal, that is easiest to manipulate, requires the shortest time to perform the tests, etc. **Mr. Conradson.**

If I were a consumer I might prepare specifications. I could then specify any instrument I wished and the producer or dealer, if he wanted my business, would have to conform to those specifications. It is up to him to use the instrument specified by the consumer. On the other hand, from a practical

Mr. Conradson. point of view, we must consider that this Society is standing as a practical and technical society to develop methods which can be easily followed without very expensive instruments, which are adapted to a great number of tests per day. However, if one laboratory or concern prefers to use any one of the instruments indicated in the committee report, and the consumer or dealer does not happen to have that viscosimeter, but has one of the others, the conversion tables prepared during the last year by the Bureau of Standards are all that is necessary, since they are sufficiently accurate for all technical and commercial purposes. I think in this discussion here we have lost sight of this practical fact.

Mr. Mackenzie. MR. MACKENZIE.—There is one point which should be clearly understood and that is the use to which the viscosimeter is now put in the testing of lubricants. The discussion seems to indicate that the object which Committee D-2 should have in mind is the most accurate method for determining absolute viscosity. If such is the case, the only instruments which can properly be considered are such as have been devised by Ostwald or Thorp & Rogers. As a matter of fact the absolute viscosity has been of no interest to either the producer or the consumer of lubricants. The connection between viscosity and lubricating value is not clearly understood, and while some contend that they are related, there are others who present equally good arguments to the opposite effect. The viscosimeter in the testing of lubricants is used simply as an instrument of control for the manufacturer in order that he may be sure of uniformity in the product he is manufacturing, and for the consumer in order that he may be sure of uniformity in the product he is receiving. It will be found that this condition does not obtain in this country alone. I have yet to see a specification for a lubricant from any part of the globe which calls for absolute viscosity. What the committee must do is to select an instrument which has sufficient accuracy for control purposes, and is yet simple enough in design and method of manipulation to give accurate results in the hands of those who are not trained physicists. We are particularly fortunate in this country in having an instrument, now in very general use, which is as accurate as any other instrument used to any extent elsewhere and is more simple. It

is certainly much more desirable to have one instrument with definite values than a number of instruments the readings on which have to be converted one into the other This is, of course, of special interest to producers of petroleum products who are now compelled to meet all sorts of specifications using all sorts of instruments, and to whom, therefore, the adoption of a single instrument would be of greatest benefit. Of probably equal importance to the adoption of the standard viscosimeter is the adoption of the standard temperatures proposed in the committee's report. These temperatures are those used throughout the United States. Unless rules are adopted for the temperatures at which viscosities are to be taken, the confusion in the specifications for lubricants will be just as serious in the future as it has been in the past, due to the fact that there are no two lubricating oils, unless of the same viscosity and made from the same crude oil, which will show the same change in viscosity with the same change in temperature. **Mr. Mackenzie.**

MR. A. C. STALKNECHT.—In so indeterminate a subject as lubricants, I cannot quite understand why the Society should adopt hard and fast rules. As I interpret Mr. Mackenzie's statement made just now, the value of the absolute viscosity of a lubricant is doubtful. Viscosity is the adhesion plus the cohesion of the lubricant, and assures us of the rate of flow through the viscosimeter's opening at the temperatures of the tests. A 31° Baumé neutral (viscosity 215) is more expensive than a 32° (viscosity 185) instrument, yet the latter may be better adapted for the particular purpose. Bearings must be flushed. The oil may be too sluggish for this work. I have worked in this field for 37 years and I do not place the producer's estimate on the value of viscosity. It is the business of this Society to get at absolute truth regarding service value. Although I have been in the position of a producer, I am now a consumer of finished products, and the determination of what these products will do is vital to me. The producer's designations are chiefly of value to him as arguments in fixing prices. For some work 27 gravity is better than 22, viscosity of 240 is better than 270, and all fire tests are mere accidents, the main purpose in distillation being to get as much of the volatile product as possible, because it generally brings a higher price than the lubricants, and the **Mr. Stalknecht.**

Mr. Stalknecht. lubricants are necessarily exposed to a higher vaporizing temperature in producing the volatiles than they are required to endure in lubrication. There are inherent factors indicative of service values which are not touched by these tests, and until the precise value of fixed viscosity can be proved, the simple Dudley pipette, whose operation the consumer can understand, would be ample for his purpose. I have put oils in actual service, of which all the laboratory tests were in accord, and found that the same bearings under the same condition of initial temperature, load, and speed would remain cool with one oil and heat with the other.

We are making no headway. While we owe very much to the producer's superior knowledge, considerations of self-interest have prevailed, so that while his tests serve to a degree in determining uniformity in comparison with previous production, they do not indicate actual commercial value. Lubricants should, of course, be neutral, they should adhere to bearings and journals, and there should be low cohesion among their own particles.

I go back to the day when Doctor Ellis, good physician and quasi-chemist, discovered that crude Pennsylvania petroleum, after cooking for a long time on his kitchen stove, was a good substitute for castor oil. It worked so well as an internal lubricant that he introduced it to the engine room. After all these years of experience, we are trying to establish its quality by the adoption of some insular viscosimeter.

Mr. Mackenzie. MR. MACKENZIE.—I fully appreciate that the real work, the valuation of lubricants, has hardly commenced. But neither can it commence until the common laboratory tests are so standardized that concordant results can be obtained.

Mr. Flowers. MR. FLOWERS.—One of the speakers has said that not much dependence was placed in viscosity values by men in practice. That is true, and the reason is because we have not been measuring viscosity. That is the secret of the difficulty. When we get to measuring viscosity, it will be time for us to consider the reconciliation of absolute viscosity with service tests, but until we do get figures of absolute viscosity, it is hopeless to get a comparison on service tests which can be corrolated with the physical tests. I am a firm believer in the possibility of pre-

determining service conditions from the physical characteristics, or the chemical characteristics which make themselves felt as physical characteristics, and it seems to me that the first step in that direction is to get to a real absolute measure of the physical properties. Let me refer to one notable piece of work along this line, that of Ubbelohde, published in *Petroleum*, April 17, May 15 and June 5, 1912, Vol. VII, pp. 773, 882 and 938. **Mr. Flowers.**

MR. HERSCHEL.—It seems to me that it makes very little difference what the connection is between viscosity and service value or whatever you may wish to call it. The main consideration in determining viscosity from the consumer's point of view, as well as the producer's, is that if you get the same results on two different tests of viscosity, it is evidence that the oil is running uniform. That is of the highest importance to the consumer just as much as to the producer. You cannot afford to waste time on service tests of oils that jump from one point to another in regard to viscosity or any other characteristic. **Mr. Herschel.**

MR. F. R. BAXTER.—It may not be out of place to state the reasons why the committee recommended the Saybolt instrument. The viscosimeters obtainable in the open market to-day and recognized as standards are the Saybolt, the Engler and the Redwood instruments. The efflux tube of the Redwood is permanent, but the method of standardizing the instrument by varying the height of the oil gage sometimes leads to wide variations between the readings of the two instruments. The oil tube cannot be easily cleaned, because of the size and position of the gage. Its water bath is so small as to require frequent attention when taking long viscosity measurements at both low and high temperatures. The water bath of the Engler is open to the same objection. Its efflux tube is tapered, making the cleaning difficult. Between viscosities the oil container must either be washed with gasoline or wiped clean with paper or cloth, with the possibility of clogging the outlet with fiber. The Saybolt instrument has a bath of liberal size; its cylindrical oil tube is easily cleaned with a leather plunger; the oil level is practically self-adjustable; viscosities can be obtained rapidly and of sufficient accuracy for commercial use. Further, it is used in this country by most of the large refiners, whose business includes the making of lubricants, and its readings are more **Mr. Baxter.**

Mr. Baxter. frequently used in drawing specifications than all others combined. Formerly there were three types of Saybolt viscosimeters, now there is only one—the Standard Universal—which the committee has recommended for adoption. This instrument can be bought from the manufacturers, and most important, the Bureau of Standards at Washington will certify its readings. It is a question of the utility of the instrument more than anything else that has induced the committee to recommend it.

Mr. McIlhiney. MR. P. C. MCILHINEY.—It seems to me that this committee has, during the last year, done a very important piece of work, but that the conclusion which they draw from their work is not exactly sound. I, for one, am not in favor of setting up as a standard for the measurement of physical properties such as viscosity or specific gravity, particular forms of instrument, such as the Saybolt viscosimeter and the Geissler pyknometer. I think it is perfectly proper for us to demand that the specific gravity shall be accurate to whatever degree is necessary, say for example the third decimal place, but that it is unwise to demand that the specific gravity shall be taken with a Geissler pyknometer. There are many other methods of determining the specific gravity which will give us the desired accuracy, whatever this may be. Many workers of experience prefer a plummet to a pyknometer. It would seem to me as sensible that in determining length we should specify that only a Browne & Sharp rule should be used, as to demand that only the Geissler pyknometer should be used for specific gravity.

As to viscosity, I think that however the viscosity is determined, the results should be expressed in terms of viscosity and not in the readings of a particular instrument. No one would think of reporting the results of an analysis in terms of the readings of his burette instead of in terms of percentage of the ingredient determined. The appendix to the report of the committee shows unmistakably that there are at least three instruments in common use, each of which is capable of determining the viscosity of lubricating oils with a satisfactory degree of accuracy, and furthermore, that the results of any of these instruments may be expressed in terms of viscosity and not merely of instrument readings. Undoubtedly the Saybolt instrument is the most frequently used in the United States and it is probably the most

convenient, but in view of the findings of the Bureau of Standards, as shown by the appendix to this committee's report, it is not logical to make the Saybolt instrument the only official instrument since the rest of the world has chosen to adopt other instruments. Our principal business is to find a practical way of enabling all three instruments to speak the same language so that we may understand each other. Whatever objections there are to the use of absolute viscosity as a means of expressing the results, may be readily overcome by a little thought and work directed to that particular end. The idea that absolute viscosity is a property requiring some particular kind of instrument to determine, is erroneous. The important thing for this committee and for us to do in this connection is to find some convenient and readily usable way of expressing real or true viscosity, either as absolute viscosity or as specific viscosity, in terms of such a convenient standard as water. Mr. McIlhiney.

MR. CONRADSON.—The gentleman who has just spoken has said many times not only to the committee but to the Society as a whole, that we have from year to year tried to produce something that apparently the Society does not want. I should like to ask the gentleman what instrument he wants for determining viscosity. The Engler, the Saybolt and the Redwood instruments are intended for commercial purposes. If we come to the point that we require absolute viscosity, we can use the Ubbelohde tables and formulas for absolute viscosity in connection with Mr. Waidner's conversion tables for the three instruments mentioned in the committee's report, but I think the committee has gone as far as it ought to go in determining the relative value of these three instruments to one another and their probable accuracy. On the other hand, if the Society is going to instruct this committee to produce another instrument, that other instrument should be an absolute viscosimeter. But absolute viscosity values in determining the value of a lubricant under service conditions is a question that has not been settled so far, either in this country or abroad. While considerable work has been done in this direction by most eminent investigators abroad, they have as yet come to no conclusion. Valuable work in this direction has been done by Mr. Flowers, and he has developed Mr. Conradson.

Mr. Conradson. an absolute viscosimeter constructed on entirely different principles from absolute viscosimeters used by other scientific investigators to determine the absolute viscosity of liquids. At present we have three commercial instruments and the committee has recommended the Saybolt because it is mostly used in this country in the oil trade, is easier to handle and is easily obtainable. This instrument is not an absolute viscosimeter, but it is a commercial instrument that so far as we know can be used for comparative tests. In conclusion, if the Society as a whole is going to instruct this committee, we would certainly be very glad to have the Society do so, but we must be instructed or advised in a definite way as to what is wanted. Does the Society want the committee to invent or develop an instrument that does not exist at present?

The Secretary. THE SECRETARY.—It seems to be manifest that, even if desirable, it would not be feasible for the Society at large to give instructions to the committee concerning a highly specialized, technical subject. The discussion, as developed here, will be reported in due course in the Proceedings. The committee is supposed to embrace leading experts on both the producing and consuming sides. If there are other experts whose counsel and service would be of advantage to the committee, they can readily be invited to membership. Such recommendations are approved almost automatically by the Executive Committee. That would appear to be the most reasonable procedure for this committee. But wholly apart from the fact that is not feasible for the Society at large to instruct the committee, it is evident that if the committee is properly constituted, such instructions would, in that case, come from a less qualified body to a better qualified body, so that the committee might be embarrassed rather than assisted by such instructions.

Mr. Flowers. MR. FLOWERS.—I should like to add one word in regard to the substantial issues at stake. The vice-chairman of the committee, Mr. Conradson, has stated that it would seem desirable that the committee should have some instructions from the Society. It has appeared from the discussion, that some of the members of the Society would be in favor of having Committee D-2 leave out of the report any statement as to the

Mr. Flowers.

particular instrument or method to be used and requiring the statement of the viscosity in terms of absolute viscosity. In order, therefore, to bring that matter before the Society, in accordance with Mr. Conradson's expressed wish, it might be desirable to put a motion of this kind before the house, "that viscosity values shall be stated in terms of absolute viscosity," and I so move. I do not mean necessarily that values should be measured in terms of absolute viscosity, though that might be desirable; but if a particular instrument is used, its name, number and test result may be stated, and in addition, the absolute viscosity shall also be stated.

The Secretary.

THE SECRETARY.—It seems to me that we are in danger of getting on rather thin ice. Can it be fairly held that this gathering is competent to give definite instructions affecting vital principles to a technical committee? I hold that it is not, and if that feeling is shared by this body, would it not be better to refer this question to the Executive Committee, so that it may institute proper inquiry before committing itself to an opinion?

Mr. Flowers.

MR. FLOWERS.—I accept that suggestion as an amendment to my motion.

[The motion, as amended, was carried.]

MR. FLOWERS (*by letter*).—Mr. Upton in his discussion presents some useful expressions for the calculation of the absolute viscosity of the commercial flow-type instruments. It should be noted that the method of evaluation for small errors has been described by Grüneisen,[1] who has gone thoroughly into the theoretical basis for this correction and also by Meissner,[2] who has presented expressions of the same form as those given by Mr. Upton, and the numerical constants for the Engler, Redwood and Saybolt viscosimeters.

Meissner gave the following forms:

$$\frac{n}{d} = a\,t - \frac{b}{t},$$

[1] "Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt," Vol. 4, No. 2, p. 154 (1904).

[2] "Vergleichende Untersuchungen über den Engler'schen, Redwood'schen, und Saybolt'schen Zähigkeitsmesser," *Chemische Revue*, Vol. 19, p. 30 (1912).

Mr. Flowers. where n = absolute viscosity, d = density, and t = outflow time in seconds.

$$t = \alpha \frac{n}{d}\left(1 + \sqrt{1 + \frac{\beta}{\left(\frac{n}{d}\right)^2}}\right).$$

$$\alpha = \frac{1}{2a} \qquad \beta = 4\,ab$$

From his test results he gave the values for α and β for the Saybolt and Redwood viscosimeters he tested. He gave also the following numerical expression for the Engler viscosimeter:

$$\frac{n}{d} = 0.08019E - \frac{0.07013}{E},$$

where E is the "Engler grad" or ratio of the outflow time to that of water at 20° C.

For the Redwood viscosimeter, Meissner's values for α and β ($\alpha = 192.2$ and $\beta = 0.01624$) do not check very well with test results and I have recalculated these constants for the Redwood viscosimeter tested and also the values for the other constants. For convenient reference these are assembled as follows:

SAYBOLT VISCOSIMETER NO. 752.

Water time at 20° C. = 28.57 seconds

$$\frac{n}{d} = 0.0021863t - \frac{1.4968}{t} \quad \text{.....(Calculated)}$$

$$t = 228.7\frac{n}{d}\left(1 + \sqrt{1 + \frac{0.01309}{\left(\frac{n}{d}\right)^2}}\right) \quad \text{.....(Quoted)}$$

REDWOOD VISCOSIMETER NO. 1263.

Water time at 20° C. = 26.47 seconds.

$$\frac{n}{d} = 0.002631t - \frac{1.5770}{t} \quad \text{.....(Calculated)}$$

$$t = 190.0\frac{n}{d}\left(1+\sqrt{1+\frac{0.01660}{\left(\frac{n}{d}\right)^2}}\right)$$ (Recalculated from Meissner's data)

ENGLER VISCOSIMETER.

Water time at 20° C. = 51.0 seconds.

$$\frac{n}{d} = 0.0015723t - \frac{3.576}{t} \quad \text{.....(Calculated)}$$

$$t = 318.0\frac{n}{d}\left(1+\sqrt{1+\frac{0.0225}{\left(\frac{n}{d}\right)^2}}\right) \quad \text{.. (Calculated)}$$

The numerical constants in the equations given here I have carefully checked and intercompared, and the insertion of the respective values for the water time at 20° C. will give the correct value for the ratio of viscosity to density within one part in a thousand, as may be seen from the following check calculation for the Saybolt Viscosimeter No. 752, whose water time is 28.57 seconds:

$$\frac{n}{d} = 0.0021863 \times 28.57 - \frac{1.4968}{28.57}$$

Log 0.0021863	=	$-3+0.33971$
Log 28.57	=	1.45591
0.062463		$-2+0.79562$
Log 1.4968	=	0.17516
Log 28.57	=	1.45591
0.052390		$-2+0.71925$

Therefore

$$\frac{n}{d} = 0.062463 - 0.052390 = 0.010073$$

This checks well with the value for $\frac{n}{d}$ if we take $\frac{n}{d} = \frac{0.01006}{0.9982}$ $= 0.01008$.

Mr. Flowers. There is a notable difference in the constants of the equations given by Mr. Upton and those calculated from Meissner's results. This difference is much greater than the relative difference of their water times.

The expression for the error is also to be found in my paper on "Viscosity Measurement and a New Viscosimeter."[1] The error curves for the Engler, Redwood and Saybolt viscosimeters have been plotted and are presented in Fig. 4 accompanying

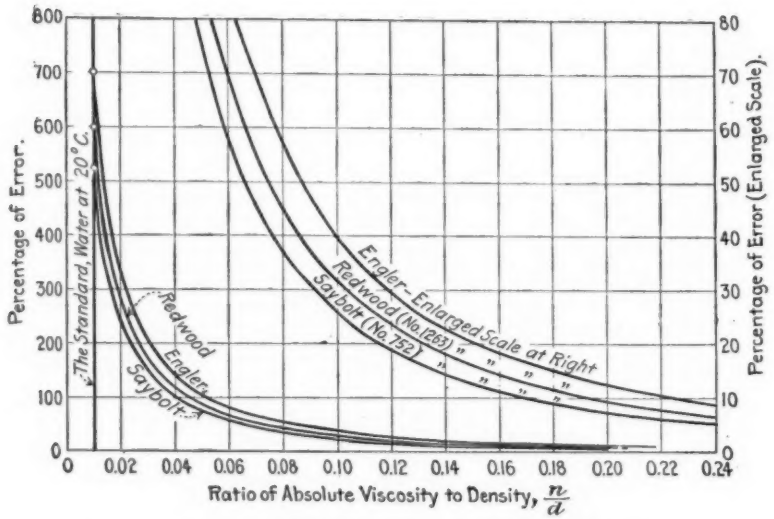


FIG. 4.—Errors of Flow-Type Viscosimeters Calculated from Meissner's Results.

this discussion. The "method" suggested by Mr. Upton is therefore to be considered as thoroughly reliable, *provided the corrections involved are not large compared to the absolute viscosity.* Unfortunately in the application of this method to the Engler, Redwood and Saybolt viscosimeters, the correction necessary when measuring or attempting to measure the viscosity of water is very large; that is, from five to seven times the value of the absolute viscosity.

Unfortunately, also, the commercial oils at the higher

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part II, p. 588 (1914).

Mr. Flowers.

temperatures have absolute viscosities which are low enough to bring them into the condition where the correction is very large indeed. Moreover, under these conditions the errors in reading the temperature, the actual time of outflow, and the quantity, all of which affect the value obtained, must therefore still more largely affect the value for the absolute viscosity obtained by this method when the corrections are as large or larger than the absolute viscosity value. Moreover, when a material is passing from lower to higher temperatures, thereby rapidly decreasing in viscosity, there is a more or less irregular change-over from the conditions of true viscous flow to the more turbulent conditions of flow, controlled partly by inertia effects and partly by viscosity. This has been made evident by a number of experimenters. The earliest work on this point is due to Hagen,[1] who showed for the case of the outflow of water through three small tubes, that as the temperature was increased and therefore the viscosity decreased, the quantity of outflow in a given time increased at first regularly, the curves plotted showing a constant slope, then the quantity of outflow decreased with continued rise of temperature, thereby showing increased retarding force in spite of the decreased viscosity. A still further increase in temperature soon resulted, however, in once more increasing the rate of discharge and again a regular increase of outflow with the increase of temperature. A similar effect is made evident from the tests recorded by Archbutt and Deeley in their book "Lubrication and Lubricants," where they show the value of the constant multiplier required to reduce the readings of a Redwood viscosimeter to absolute viscosity for different mixtures of glycerin and water. Their curve shows an irregularity at the point which would correspond to the critical velocity for this instrument with the kind of samples used. It is to be noted that this critical velocity depends upon the length of the outflow tube, upon its diameter, and upon the density of the fluid. The critical velocity therefore will be different for each sample and for each outflow tube. This critical velocity condition cannot be taken account of at all in the simple expressions given by Mr. Upton, Grüneisen, Meissner, etc., for the reason that the form of the motion undergoes a marked change at this critical velocity.

[1] "Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin," p. 17 (1854).

Mr. Flowers. Finally, it must be noted that the value obtained from any of these instruments is not the viscosity alone, but the ratio of the viscosity to the density. The density therefore must be determined separately for the temperatures of the test.

I agree heartily in the statement that the trend of progress is from empirical to absolute units and that our Society might require statements of results in absolute units.

It is to be hoped, too, that the Bureau of Standards may agree to supply materials for standardizing purposes whose viscosity and density have been accurately determined for a suitable range of temperatures.

Mr. Upton has rendered the committee, the Society, and all users of viscosimeters, however, a great service in calling attention to, tabulating, and presenting in the shape of curves and equations these results, which should be compared with the values from Meissner's results.

Mr. Upton. MR. UPTON (*Closure by letter*).—In reply to Mr. Flowers, I have realized that the formula $\frac{n}{d} = At - \frac{B}{t}$ was only an approximate formula for the flow viscosimeter. The values of A and B vary with the viscosity, with initial head, with the ratio of drop of head during the run to initial head, and with the form and dimensions of the discharge orifice. The formula is accurate apparently within one per cent., when A and B are found by running two known liquids with values of $\frac{n}{d}$ respectively near the two limits of the range of $\frac{n}{d}$ values to be measured. I proposed distilled water and a standardized oil as calibration liquids. It would be better to use a light oil and a heavy oil, because many of the present commercial instruments do not give truly viscous flow with water. The equation is competent to take care of kinetic energy in the discharging fluid, but not to take care of turbulent flow. It happens that the time of flow for the turbulent condition is not, for water in the commercial viscosimeters, greatly different from that for viscous flow. I did not wish to complicate my previous discussion with the detail as to this. The present flow viscosimeter would have to be redesigned to make them accurate on water, or fluids of low absolute viscosities.

Mr. Upton.

The irregularity in Archbutt and Deeley's reducing factors for the Redwood and other viscosimeters is not due to the passing of the critical velocities, but to an error in their table of viscosities of glycerin-water mixtures. This error becomes apparent if one plots their viscosity values against densities of the solutions, using water as the end member of the series.

I trust that discussion of these minor details may not interfere with our vision as to the main point at issue: the desirability of statement of results in absolute units, and the ease with which such statement may be made by calibration of the individual instruments with two known liquids, determining the *A* and *B* constants for the instrument.

Messrs. Van Gundy, Conradson and Mackenzie.

MR. C. P. VAN GUNDY, MR. P. H. CONRADSON and MR. K. G. MACKENZIE (*Officers of Committee D-2—Closure by letter*).—The committee feels that in the extended discussion which has taken place, some practical points may have been obscured and that a brief return to them may not be out of order. By the laboratory methods now in use, the action of a lubricant can not be absolutely forecasted, and the largest consumers generally base their purchases upon service tests, carried on for a sufficient length of time to prove the fitness for the work in question of the oils under consideration. At the same time these oils are given the usual laboratory tests, and the consumer uses the data thus obtained as a check on later shipments. These tests are, therefore, mainly comparative and are used as a means of control.

The committee is by no means pessimistic over the possibility of ultimately arriving at laboratory tests that will give in advance full indications of the value of a particular oil for a particular purpose; but the devising of such tests will cover a very long period of time, and the committee, being aware of the confusion which now exists in the applied methods, felt that the first step which it should take would be the standardization of these present laboratory methods of control, in order that on the same product, the same results could be obtained by different operators in different places.

The valuable work done by Mr. Waidner on the intercomparison of the Saybolt Universal, Redwood and Engler viscosimeters demonstrates without valid contradiction that the Say-

Messrs. Van Gundy, Conradson and Mackenzie.

bolt Universal is equally as reliable and accurate as the two other foreign instruments, and in addition, it is an undisputed fact that it is much more easy to manipulate and is by far the most generally used in this country. These considerations, in connection with the fact that Mr. Waidner's tables have made the readings of the three instruments readily interchangeable, fully justify the committee in reaffirming its recommendation of last year regarding the Saybolt Universal viscosimeter.

The suggestion is made that viscosity be determined by the use of some instrument that will give directly readings in absolute viscosity. This is out of the question, so far as present absolute instruments on the market are concerned, since they are all too complicated to be used in the practical control of the quality of lubricants. This feature of practicability should not be lost sight of; and, while the determination of the absolute viscosity may give valuable information, the committee would not recommend for adoption by the Society any instrument too complicated or too fragile for general use in the laboratories of the producers or consumers of lubricants. However, several instruments of the absolute type have been recently described and illustrated in some of the technical journals, and will undoubtedly be considered and investigated by the committee, should they become available in the market, and there be a demand for such study.

The discussion and criticisms of the other standard test methods covered in the report, such as specific gravity, free acid, cloud and pour test, will be carefully considered by the committee, and those having merit will be used wherever corresponding changes or modifications are deemed advisable.

REPORT OF COMMITTEE D-4

ON

STANDARD TESTS FOR ROAD MATERIALS.

Committee D-4 has carefully considered the reports of the two special Joint Committees which were appointed to take under advisement the Definitions and the Proposed Provisional Tests and Methods recommended in its 1914 report to the Society. The reports of the Joint Committees referred to will be found in Appendices I and II to this report.

The Joint Committee representing Committees C-9, D-8 and D-4 approved many of the definitions recommended by Committee D-4, but suggested changes in certain others (see Appendix I). The revised definitions which have been accepted by Committee D-4 are included in the following list, with a record of the letter ballot of the committee:

PROPOSED REVISED DEFINITIONS.

**Asphalt Cement.*—A fluxed or unfluxed asphalt specially prepared as to quality and consistency for direct use in the manufacture of bituminous pavements, and having a penetration at 25° C. (77° F.) of between 5 and 250, under a load of 100 g. applied for 5 seconds.

Affirmative, 26; negative, 3; not voting, 4.

**Blown Petroleums.*—Semi-solid or solid products produced primarily by the action of air upon liquid native bitumens which are heated during the blowing process.

Affirmative, 24; negative, 5; not voting, 4.

**Native Asphalt.*—Asphalt occurring as such in nature.

Affirmative, 28; negative, 1; not voting, 4.

**Crusher Run.*—The total unscreened product of a stone crusher.

Affirmative, 29; negative, 1; not voting, 3.

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* Approved by the Joint Conference Committee.

**Stone Chips.*—Small angular fragments of stone containing no dust.

Affirmative, 30; negative, 0; not voting, 3.

Matrix.—The binding material or mixture of binding material and fine aggregate in which the large aggregate is embedded or held in place.

Affirmative, 28; negative, 1; not voting, 4.

The committee wishes to direct attention to the fact that it has withdrawn the definitions of the following terms, the withdrawal of which has been put to letter ballot of the committee with the following results:

Dust:

Affirmative, 23; negative, 7; not voting, 3.

Flour:

Affirmative, 24; negative, 6; not voting, 3.

Spawl:

Affirmative, 25; negative, 5; not voting, 3.

The committee recommends that the above revised definitions, together with those proposed in 1913 and 1914 which have not been changed or withdrawn,—all of which are appended to this report under the title "Proposed Standard Definitions for Terms Applicable to Materials Relating to Roads and Pavements,"—be referred to letter ballot of the Society for adoption.[1]

In addition the committee recommends that the following Definitions of Non-Bituminous Road Materials be printed in the Proceedings for one year, as prescribed in the Regulations Governing Technical Committees, and that such Definitions be referred to letter ballot of the Society a year hence.[2] The definitions have been submitted to letter ballot of the committee with results as noted.

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* Approved by the Joint Conference Committee.

[1] These definitions are not reprinted here, but they appear in the 1915 Year-Book.—ED.

[2] In presenting this report at the annual meeting, Committee D-4 recommended that these definitions be referred back for further consideration. See p. 29.—ED.

PROPOSED STANDARD DEFINITIONS OF NON-BITUMINOUS ROAD MATERIALS.

**Aggregate.*—The mineral material, such as sand, gravel, shells, slag, or broken stone, or combinations thereof, with which the cement or the bituminous material is mixed to form a mortar or concrete. Fine aggregate may be considered as the mineral inert material which will pass a ¼-in. screen, and coarse aggregate the material which will not pass a ¼-in. screen.

Affirmative, 26; negative, 3; not voting, 4.

Ashes.—Finer portions of the product of combustion.

Affirmative, 17; negative, 12; not voting, 4.

Bank Gravel.—Gravel found in natural deposits, usually more or less intermixed with sand, clay, etc.; gravelly clay, gravelly sand, clayey gravel, and sandy gravel indicate the varying proportions of the admixture of the finer materials.

Affirmative, 22; negative, 7; not voting, 4.

**Binder.*—(1) A foreign or fine material introduced into the mineral portion of the wearing surface for the purpose of assisting the road metal to retain its integrity under stress, as well as, perhaps, to aid in its first construction. (2) The course, in a sheet-asphalt pavement, frequently used between the concrete foundation and the sheet-asphalt mixture of graded sand and asphalt cement.

Affirmative, 22; negative, 7; not voting, 4.

Cinders.—Coarser portions of the product of combustion, more especially those remaining from incomplete combustion.

Affirmative, 19; negative, 10; not voting, 4.

**Clay.*—Finely divided earth, generally silicious and aluminous, which will pass a 200-mesh sieve.

Affirmative, 18; negative, 11; not voting, 4.

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* Included in the 1915 Report of the Special Committee on "Materials for Road Construction" of the American Society of Civil Engineers.

**Filler.*—(1) Relatively fine material used to fill the voids in the aggregate. (2) Material used to fill the joints in a brick or block pavement.

Affirmative, 26; negative, 3; not voting, 4.

Gravel.—Small stones or pebbles which will not pass a 10-mesh sieve. The differentiation between gravel, sand, silt, and clay should be made on the following basis:

SIZES OF PARTICLES.	NAMES.
Retained on a 10-mesh sieve	Gravel
Passing a 10-mesh and held on a 200-mesh sieve	Sand
Passing a 200-mesh sieve	Silt or Clay

Affirmative, 21; negative, 7; not voting, 5.

Grit.—Stone chips, slag chips, or small gravel.

Affirmative, 26; negative, 3; not voting, 4.

**Loam.*—Finely divided earthy material containing a considerable proportion of organic matter.

Affirmative, 25; negative, 4; not voting, 4.

**Macadam.*—A road crust composed of stone or similar material broken into irregular angular fragments compacted together so as to be interlocked and mechanically bound to the utmost possible extent.

Affirmative, 25; negative, 4; not voting, 4.

**Sand.*—Finely divided rock detritus the particles of which will pass a 10-mesh and be retained on a 200-mesh sieve.

Affirmative, 21; negative, 7; not voting, 5.

**Screen.*—In laboratory work an apparatus, in which the apertures are circular, for separating sizes of material.

Affirmative, 25; negative, 4; not voting, 4.

Screenings.—Broken rock, including the dust, of a size that will pass through a $\frac{1}{2}$ to $\frac{3}{4}$-in. screen, depending upon the character of the stone.

Affirmative, 24; negative, 4; not voting, 5.

* Included in the 1915 Report of the Special Committee on "Materials for Road Construction" of the American Society of Civil Engineers.

Sieve.—In laboratory work an apparatus in which the apertures are square, for separating sizes of material.

Affirmative, 24; negative, 4; not voting, 5.

**Silt.*—Naturally deposited fine earthy material, which will pass a 200-mesh sieve.

Affirmative, 22; negative, 6; not voting, 5.

After considerable investigation, Committee D-4 wishes to express its approval of the findings of the Joint Conference Committee consisting of members of Committees C-9 and D-4, which was appointed to consider the Proposed Provisional Tests and Methods recommended in 1914. As a result it recommends that letter ballot on these tests and methods be deferred pending final action of the Joint Conference Committee. A progress report of the Joint Conference Committee is given in Appendix II to this report.

In addition the committee, with a view to avoiding duplication of work on details and in order to hasten consideration of the important tests for determining the specific gravity of sand and fine aggregate and voids in mineral aggregates, recommends the following:

1. That the Jackson specific gravity apparatus be used for the determination of the specific gravity of sand and fine aggregates.

2. That voids in mineral aggregates be determined by the Cone specific gravity method. It is suggested that the following method of using a truncated cone—made of No. 18 B. & S.-gage galvanized steel with calked seams and having the following dimensions: overall diameter of bottom, 25.4 cm. (10 in.); overall height 25.4 cm. (10 in.); inside diameter of opening, 7.6 cm. (3 in.)—be adopted as the basis for investigation: (1) thoroughly mix the aggregate by rolling on paper; (2) fill the cone with aggregate, avoiding segregation; (3) compact aggregate in cone by oscillation on edge of cone resting on wooden floor, wooden box or block of wood and use cotton waste pressed against surface of aggregate to prevent segregation during oscillation; (4) continue to add aggregate and compact until

*Included in the 1915 Report of the Special Committee on "Materials for Road Construction" of the American Society of Civil Engineers.

the cone is full of thoroughly compacted aggregate which process will require from 300 to 500 oscillations; (5) weigh cone with aggregate; (6) weigh cone empty; (7) weigh cone full of clean water; (8) determine the specific gravity of aggregate; (9) the percentage of voids in the aggregate shall be calculated by the following formula:

$$\text{Percentage of Voids} = \left(1 - \frac{(C-A)}{(B-A)D}\right) 100$$

in which A = the weight in grams of the cone; B = the weight in grams of the cone filled with water; C = the weight in grams of the cone filled with compacted aggregate; D = the specific gravity of the aggregate.

3. That products of rock-crushing plants be covered in specifications by stating that the product shall conform to limitations given in terms of mechanical analyses made with laboratory screens. The following clauses are given as illustrations:

The No. 2 size broken stone shall conform to the following analysis, using laboratory screens having circular openings: Not more than 75 per cent of the broken stone shall pass and not more than 75 per cent shall be retained on a ¾-in. screen.

The No. 2 size broken stone shall conform to the following mechanical analysis, using laboratory screens having circular openings: All of the broken stone shall pass a 1¼-in. screen; not more than 25 per cent shall pass a 1¼-in. screen and be retained upon a ¾-in. screen; not more than 10 per cent shall pass a ¼-in. screen.

The No. 2 size broken stone shall conform to the following mechanical analysis, using laboratory screens having circular openings: All of the broken stone shall pass a 1¼-in. screen; not more than 25 per cent nor less than 10 per cent shall pass a 1¼-in. screen and be retained upon a ¾-in. screen; not more than 10 per cent nor less than 2 per cent shall pass a ¼-in. screen.

"Broken stone specified as 1½-in. gage shall all pass through a 1½-in. ring, and shall consist of the following percentages by weight: Not more than 15 per cent passing through a 1-in. ring in every direction; not less than 65 per cent over 1 in. and not exceeding 2 in. in greatest length by measurement; not more than 20 per cent over 2 in. in greatest length by measurement." (Specification adopted by the Engineering Standards Committee of Great Britain.)

"One-inch chippings must all be capable of passing through a square hole of 1-in. side and at least 70 per cent by weight must be retained by sieves having square holes of ¾-in. side." (Specification adopted by the Engineering Standards Committee of Great Britain.)

The reports of sub-committees which have developed results of sufficient interest are submitted as progress reports in Appendices III, IV and V of this report.

The report of the Sub-Committees on Softening Point (Appendix III) and on Ductility Tests (Appendix IV) are given because it is felt that the data presented will prove of value to those interested in the tests, and may lead to suggestions which will materially assist the committee in the final selection of methods to be recommended to the Society for adoption as standard.

The report of the Sub-Committee on Penetration (Appendix V) embodies certain details not covered in the present Provisional Method for the Determination of the Penetration of Bitumen.[1] Before recommending the new test for adoption, however, the committee wishes to carry out further investigations which have recently been suggested.

This report has been submitted to letter ballot of the committee, which consists of 33 members, of whom 31 have voted affirmatively, none negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the committee,

L. W. PAGE,
Chairman.

PRÉVOST HUBBARD,
Secretary.

[EDITOR'S NOTE.—For action taken on this report, see page 29.

The proposed Standard referred to in the report was adopted by letter ballot of the Society on August 21, 1915, and appears among the Standards in the 1915 Year-Book.

For Discussion on the report, see page 356.]

[1] 1914 Year-Book, p. 344.

APPENDIX I.

REPORT OF SPECIAL JOINT COMMITTEE APPOINTED TO CONSIDER DEFINITIONS OF ROAD MATERIALS.

The special Joint Committee appointed for the purpose of considering the proposed standard definitions[1] recommended by Committee D-4 in 1913 and 1914, desires to submit the following report:

This committee has held one meeting at which the following members were present: Prévost Hubbard, *Chairman*, and W. W. Crosby, representing Committee D-4; L. R. Ferguson, representing Committee C-9; S. R. Church, K. G. Mackenzie and R. J. Wig, representing Committee D-8.

The proposed definitions were considered and the Joint Committee respectfully recommends their adoption as given below.[2] All definitions were unanimously agreed to except where otherwise noted. Where any member of the joint committee voted in the negative an explanation of his reasons for so voting is appended to this report.

PROPOSED STANDARD DEFINITIONS OF NON-BITUMINOUS ROAD MATERIALS.

Crusher-Run.—The total unscreened product of a stone crusher.

Dust.—(*a*) The product of a rock crusher passing through a fine screen or sieve, the size to be specified but not in any case to be larger than $\frac{1}{4}$ in.

Mr. Wig voted in the negative.

(*b*) Earth or other matter in fine, dry particles, so attenuated that they can be raised and carried by air currents.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, pp. 375–377, 383–384 (1914).

[2] Of the 38 terms involved in the report, 24 were unanimously adopted by the Joint Committee in the form originally presented by Committee D-4. These terms are not given here, but appear in the "Proposed Standard Definitions of Terms Applicable to Materials Relating to Roads and Pavements" (see 1915 Year-Book). The remaining 14 terms, including 3 which have been withdrawn by Committee D-4, are listed below.—ED.

Flour.—Finely ground rocks or minerals pulverized to an impalpable powder. The average diameters of the larger particles are not in excess of approximately 0.001 in.

Matrix.—A mixture of binding material and fine aggregate in which the large aggregate is embedded or held in place.

Spawl.—A small piece of rock flaked from the surface.

Stone Chips.—Small angular fragments of stone containing no dust.

PROPOSED STANDARD DEFINITIONS OF BITUMINOUS ROAD MATERIALS.

Solid Bituminous Materials.—Those having a penetration at 25° C. (77° F.), under a load of 100 g. applied for 5 seconds, of not more than 10.

Mr. Mackenzie voted in the negative.

Liquid Bituminous Materials.—Those having a penetration at 25° C. (77° F.), under a load of 50 g. applied for 1 second, of more than 350.

Mr. Mackenzie voted in the negative.

Semi-Solid Bituminous Materials.—Those having a penetration at 25° C. (77° F.), under a load of 100 g. applied for 5 seconds, of more than 10, and a penetration at 25° C. (77° F.), under a load of 50 g. applied for 1 second, of not more than 350.

Mr. Mackenzie voted in the negative.

Asphalt Cement.—A fluxed or unfluxed asphalt specially prepared as to quality and consistency for direct use in the manufacture of bituminous pavements, and having a penetration at 25° C. (77° F.) of between 5 and 250, under a load of 100 g. applied for 5 seconds.

Mr. Mackenzie voted in the negative.

Native Asphalt.—Asphalt occurring as such in nature.

PROPOSED STANDARD DEFINITIONS OF TERMS APPLICABLE TO MATERIALS RELATING TO ROADS AND PAVEMENTS.

Blown Petroleums.—Semi-solid or solid products produced primarily by the action of air upon liquid native bitumens which are heated during the blowing process.

Oil-Gas Tars.—Tars produced by cracking oil vapors at high temperatures in the manufacture of oil gas.

Mr. Crosby voted in the negative.

Water-Gas Tars.—Tars produced by cracking oil vapors at high temperatures in the manufacture of carburetted water gas.

Mr. Crosby voted in the negative.

This report has been submitted to letter ballot of the Joint Committee, which consists of 9 members, of whom 7 have voted affirmatively, none negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the joint committee,

PRÉVOST HUBBARD,
Chairman.

EXPLANATORY STATEMENTS IN SUPPORT OF DISSENTING VIEWS.

March 20, 1915.

MR. PRÉVOST HUBBARD,
Chairman, Joint Committee of Committees C-9, D-4, and D-8.

Dear Sir:

At the meeting of the Joint Committee on Definitions for Bituminous Materials of Committees C-9, D-4 and D-8, the undersigned was unable to give his approval to four of the definitions as recommended by Committee D-4, and begs to submit herewith a minority report explaining the reasons for his objections to these definitions, and offering suggestions for changes and modifications.

On page 376, of Vol. XIV, Part 1, Proceedings of the American Society for Testing Materials, the following definitions occur:

Solid Bituminous Materials.—Those having a penetration of 25° C. (77° F.) under a load of 100 g. applied for 5 seconds, of not more than 10.

Liquid Bituminous Materials.—Those having a penetration at 25° C. (77° F.), under a load of 50 g. applied for 1 second, of not more than 350.

Semi-Solid Bituminous Materials.—Those having a penetration at 25° C. (77° F.), under a load of 100 g. applied for 5 seconds, of more than 10, and a penetration at 25° C. (77° F.), under a load of 50 g. applied for 1 second, of not more than 350.

It would seem that Committee D-4 was unfortunate in going further with these definitions than it has in the other very excellent definitions which it has outlined, by making them more of a specification than a definition. It would hardly seem possible that any one is in a position to lay down a hard and fast rule which shall separate solid, semi-solid, and liquid materials. It would appear that an exact specification for solid, semi-solid, and liquid materials would rather belong to the province of specifications than that of definitions, and that the omission of specifications for these three states of matter would not in any way detract from the value of the other definitions which Committee D-4 has drawn up.

However, since it seems very essential in the opinion of the members of Committee D-4, that the Society have strict definitions for solid, semi-solid, and liquid materials, as referring to bituminous materials, it is suggested that these three definitions be referred back to the committee for further consideration, and that in this further consideration, they consider not only the penetrometer, but also other instruments which are equally as well adapted to differentiating between these various states of matter; and that it is respectfully suggested that an investigation of the Page impact machine might show that instrument to be superior to the penetrometer to differentiate between solid and semi-solid materials. The definition, as drawn, states that a solid is a material into which a needle will sink a certain distance under a given weight, and a semi-solid is a material into which a needle will sink a greater distance, hardly classifying semi-solid and solid materials as they are usually considered. With the Page impact machine a material which is brittle would come nearer our conception of a solid, and a material which is not brittle that of a semi-solid. In differentiating between liquid and semi-solid bodies, the penetrometer would scarcely

seem to be the instrument which should be employed. For this differentiation an instrument is required by which both liquids and semi-solids can be tested, and up to the present time no such instrument has been worked out satisfactorily. A viscosimeter capable of registering viscosity of both liquids and semi-solids at normal temperatures might fill this want. The distance which a needle will penetrate into the mass would hardly seem to specify accurately what is usually considered either semi-solid or liquid.

On page 377 there occurs a definition for Asphalt Cement as follows:

Asphalt Cement.—A fluxed or unfluxed asphalt specially prepared as to quality and consistency for direct use in the manufacture of bituminous pavements, and having a penetration of between 5 and 250.

It is suggested that that part of the definition following "bituminous pavements" be stricken out, the same reason applying in this case as applied in the case of solid, semi-solid, and liquid materials.

It is therefore respectfully suggested that Committee D-8 recommend to the Society that the four definitions in question be referred back to Committee D-4 for further consideration.

Respectfully submitted,

K. G. MACKENZIE.

March 6, 1915.

MR. PRÉVOST HUBBARD,

Chairman, Joint Committee of Committees C-9, D-4 and D-8.

Dear Sir:

I vote "no" on the motion to recommend the adoption of the definitions for "oil-gas tars" and "water-gas tars," proposed by Committee D-4, because of the inclusion of the words "at high temperatures." I think that these words are confusing to the lay mind, since the word "high" is indefinite. I think the phrase is entirely unnecessary when the rest of the definition is taken into account.

Very respectfully,

W. W. CROSBY.

March 24, 1915.

MR. PRÉVOST HUBBARD,
Chairman, Joint Committee of Committees C-9, D-4 and D-8.

My dear Mr. Hubbard:

I desire to offer the following in explanation of my vote on the definition of "dust."

The definition for "dust" adopted by the committee is contrary to the common usage of this term, which is used as defined only in certain local and specialized fields of road construction. The word is here defined as synonymous to the commonly used term "screenings" which is quite generally accepted as the product of a crusher passing a $\frac{1}{4}$-in. screen. In specifications for concrete, which is a common road material, it is often stated that "the aggregate shall be free from dust." It is there used in its commonly accepted sense as the very fine material which may adhere to or coat the larger particles. It would seem that no definition should be crystallized by this Society and promulgated as a standard unless it conforms in meaning to that commonly applied, or if it is given a specialized and technical meaning, it should be subject to but one interpretation and should be applicable, without ambiguity, to the entire field or industry in which it is commonly used.

Very respectfully,

RUDOLPH J. WIG.

APPENDIX II.

REPORT OF SPECIAL JOINT COMMITTEE APPOINTED TO CONSIDER PROVISIONAL TESTS OF ROAD MATERIALS.

The special Joint Committee appointed for the purpose of considering the proposed provisional tests and methods[1] recommended by Committee D-4 in 1914, desires to submit the following report in the form of the minutes of its meeting held on March 19, 1915, at Columbia University, New York City.

The meeting was called to order by the chairman, Mr. A. H. Blanchard, at 8.15 p. m. The following members were present: Messrs. C. M. Chapman, D. A. Abrams, and R. E. Goodwin, representing Committee C-9; and Messrs. A. W. Dow, A. N. Johnson, and A. H. Blanchard representing Committee D-4. Mr. R. E. Goodwin represented Mr. G. L. Lucas under authorization from Mr. Sanford E. Thompson, Chairman of Committee C-9, and Mr. A. W. Dow represented Mr. Francis P. Smith, under authorization of Mr. L. W. Page, Chairman of Committee D-4.

A letter from the Secretary-Treasurer of the Society pertaining to the appointment and work of the joint sub-committee was read by the chairman.

The Provisional Tests and Methods were taken up for consideration in the order in which they were presented in the 1914 Report of Committee D-4.

Proposed Provisional Test for the Determination of the Apparent Specific Gravity of Rock.—After an exhaustive discussion of methods of determining apparent specific gravity of all kinds of materials used for road metal and for coarse aggregate in cement concrete, such as rock, slag, broken building and paving brick, etc., it was voted to investigate the relative adaptability of the method proposed by Committee D-4 and an alternate method proposed by Mr. C. M. Chapman of Committee C-9, using a set of standard samples, varying widely in absorption, which

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, pp. 378–382 (1914).

would be tested by the two methods in the six laboratories represented by the members of the joint committee.

The alternate method proposed by Mr. Chapman is as follows:

> The apparent specific gravity shall be determined in this manner: (1) A sample which will pass through a 1-in. circular opening and which will not pass a ½-in. circular opening, and approximately cubical or spherical in shape, shall be dried to constant weight at a temperature between 100 and 110° C. (212 and 230° F.); (2) the dried sample shall be weighed in air to 0.01 g., (3) the dried sample, which is suspended on a fine wire or thread, shall be immersed in clean water having a temperature between 15 and 25° C. (60 and 77° F.) for 5 to 10 minutes or any greater time, or until no air bubbles appear on the surface of the sample; (4) the immersed sample, after all air bubbles shall have been removed from the surface and after the scales have been balanced, shall be allowed to remain immersed for one minute and, if any change in weight takes place, the sample shall remain in water until the balance remains constant within 0.01 g. for one minute; (5) the sample shall be immediately removed from the water after weighing, the surface water shall be wiped off with a towel or filter paper, and the wet sample shall be rapidly weighed in air; (6) the apparent specific gravity of the sample shall be calculated by dividing the weight in grams of the dry specimen by the difference between the weights of the saturated specimen in air and in water.
>
> Finally the apparent specific gravity of the material shall be the average of three determinations made on three different samples according to the method above described.

Proposed Provisional Test for the Determination of the Absorption of Water per Cubic Foot of Rock.—It was voted to postpone consideration of the absorption test recommended by Committee D-4, as the details of this test are intimately related to the details of the method used for the determination of apparent specific gravity.

Proposed Provisional Methods for making Mechanical Analyses of Broken Stone or Broken Slag and Mixtures of Sand or other Fine Material with Broken Stone or Broken Slag.—The present status of making and recording mechanical analyses of mineral aggregates was discussed at length. It was pointed out that there are several series of screens and sieves in use and that sieves of the same mesh are made of different sizes of wire. The oldest series of sieves and the one in general use in road and paving work consists of eight sieves designated as 10, 20, 30, 40, 50, 80, 100, and 200 mesh. This set of sieves was adopted by the

Society as standard on August 21, 1911, and is described under "Provisional Method for Sizing and Separating Aggregate in Asphalt Paving Mixtures."[1] Another series of sieves, which is used by some cement concrete and mining engineers, has openings increasing in the ratio of $\sqrt{2}=1.414$. It was also pointed out that various methods of making and recording mechanical analyses are in general use.

It was voted to thoroughly investigate the practicability of using the same series of screens and sieves and the same methods of making and recording mechanical analyses in all branches of engineering.

It was voted to transmit the minutes of this meeting as a progress report, and to present a final report to the Executive Committee of the Society and to Committees C-9 and D-4 on or before March 1, 1916.

Respectfully submitted on behalf of the Joint Committee,

A. H. BLANCHARD,
Chairman.

[1] 1914 Year-Book, p. 346.

APPENDIX III.

REPORT OF SUB-COMMITTEE ON SOFTENING POINT.

Several members submitted data at a meeting of the sub-committee on work they had done on softening-point determination on different materials by various methods, and after an informal and somewhat lengthy discussion, it was decided tests would be made on standard samples by the ring-and-ball and cube methods only, other methods of making the determination to be deferred for future investigation.

Ring-and-Ball Method.—In order that all tests might be made with uniform apparatus, it was decided that: the ring-and-ball test should be made with a $\frac{5}{8}$-in. ring, $\frac{1}{4}$ in. deep, having a wall $\frac{3}{32}$ in. thick; the ball to be of steel $\frac{3}{8}$ in. in diameter; the bath to be approximately 400 cc. of glycerin in a 600-cc. beaker; the test to start at 5° C. (41° F.), the temperature to be raised 5° C. (9° F.) per minute; the drop of the specimen to be 1 in. The time of the test is to be taken in every case.

The reason for starting the test at the low temperature is to have it low enough to include the softest of the standard specimens. The rate of heating, 9° F., was chosen because it is exactly 5° C. Formerly the common rate of heating was 10° F. Glycerin was substituted for water because some of the specimens to be tested will be above the boiling point of water.

In making the tests considerable difficulty was experienced in heating glycerin uniformly at low temperatures. Water was therefore substituted in nearly all cases except for the hardest materials.

Cube Method.—It was decided to follow the method of making the cube test as reported by the committee of the American Society of Civil Engineers, except that the starting temperature should be 5° C. (41° F.), the heat should be applied at the rate of 5° C. (9° F.) per minute, and the drop should be 1 in.

Samples were procured from the Sub-Committee on

Standard Samples of Sub-Committee I. Thermometers were furnished by one maker but these instruments were not restandardized.

The results obtained by the various laboratories in testing the standard samples are shown in Figs. 1 to 6, inclusive. Three grades of each material were tested by the two methods. Six laboratories worked on identical standard samples. Five laboratories used similar thermometers. Following is a brief description of the manner of conducting tests in each laboratory:

Standard Oil Co. Laboratory.—Different operators, different apparatus, different laboratories. Glycerin used only with specimen No. 18.

Brooklyn Municipal Laboratory.—Same apparatus, but different operators. Results shown in ring-and-ball method were obtained with water bath, except with specimen No. 18.

Barrett Manufacturing Co. Laboratory.—Duplicate tests, same apparatus, same operator. Water bath used, except with specimens Nos. 9, 12, 15 and 18, when glycerin was used.

Columbia University Laboratory.—Same operator, different apparatus. Water bath used, except with specimens Nos. 3, 6, 9, 12, 15, 17, and 18, which were tested in glycerin.

Hastings Pavement Co. Laboratory.—Same apparatus, different operators. Water bath used, except with specimen No. 18, which was tested in glycerin.

Barber Asphalt Co. Laboratory.—Different apparatus, same operator. Water bath used, except with specimen No. 18.

The ring-and-ball method gave more uniform results than the cube method, and while the ring-and-ball method showed itself to be the more convenient and gave the more concordant results, its adoption as standard is not recommended until further refinements have been devised and other methods investigated.

Respectfully submitted on behalf of the Sub-Committee on Softening Point,

G. P. HEMSTREET,
Chairman.

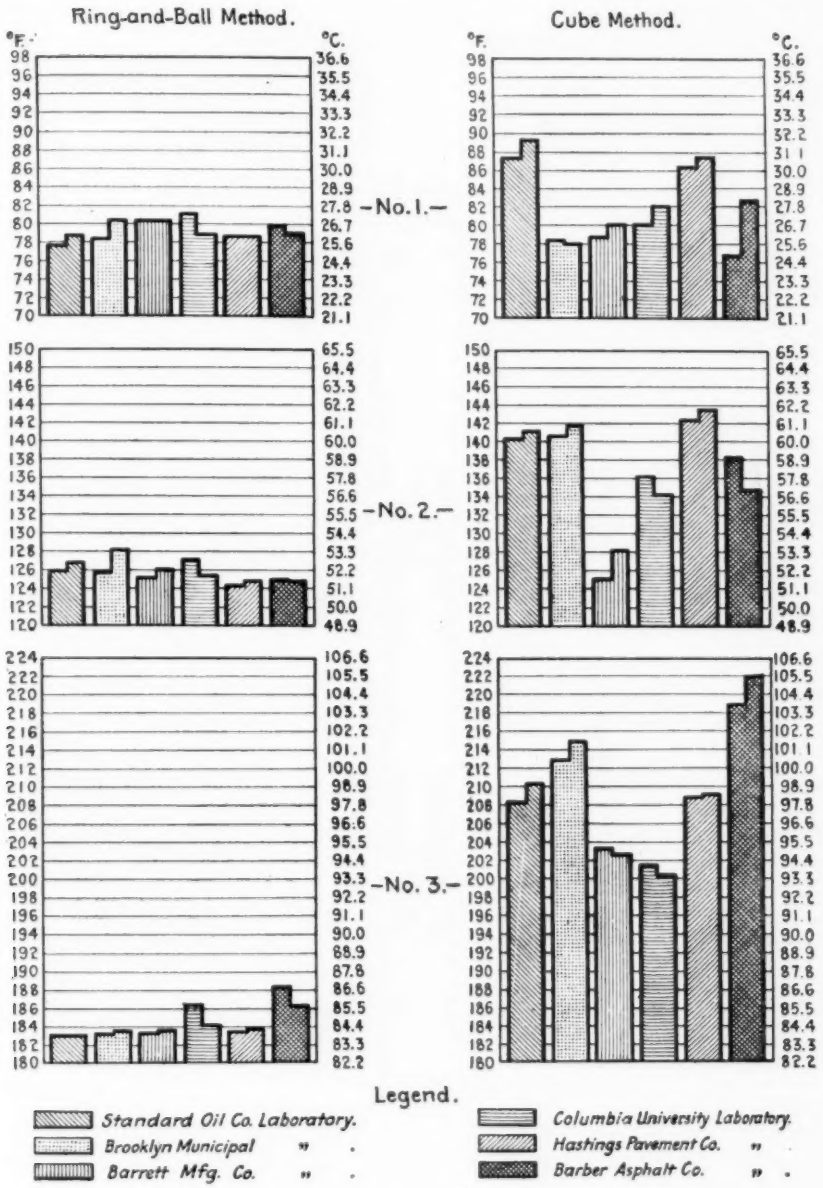

FIG. 1.—Determination of Softening Point on Water-Gas Tar Pitches.

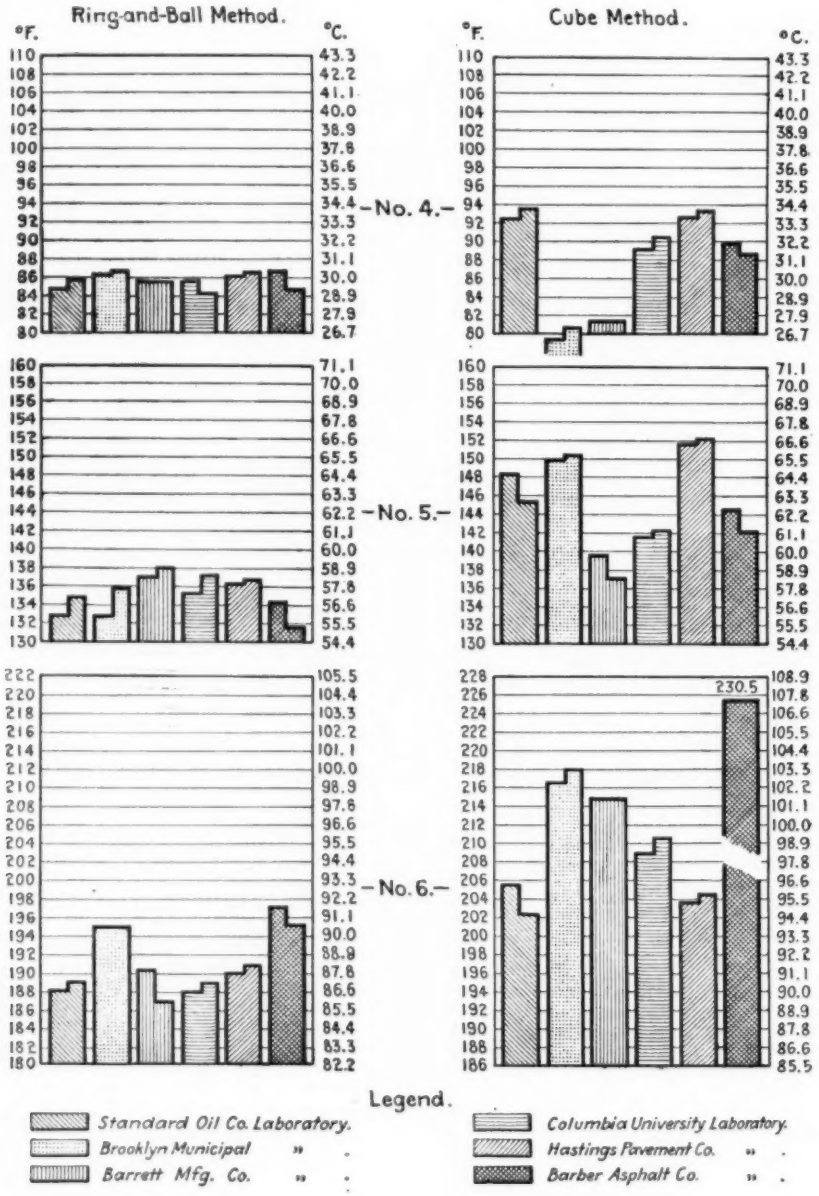

FIG. 2.—Determination of Softening Point on Coal Tar Pitches.

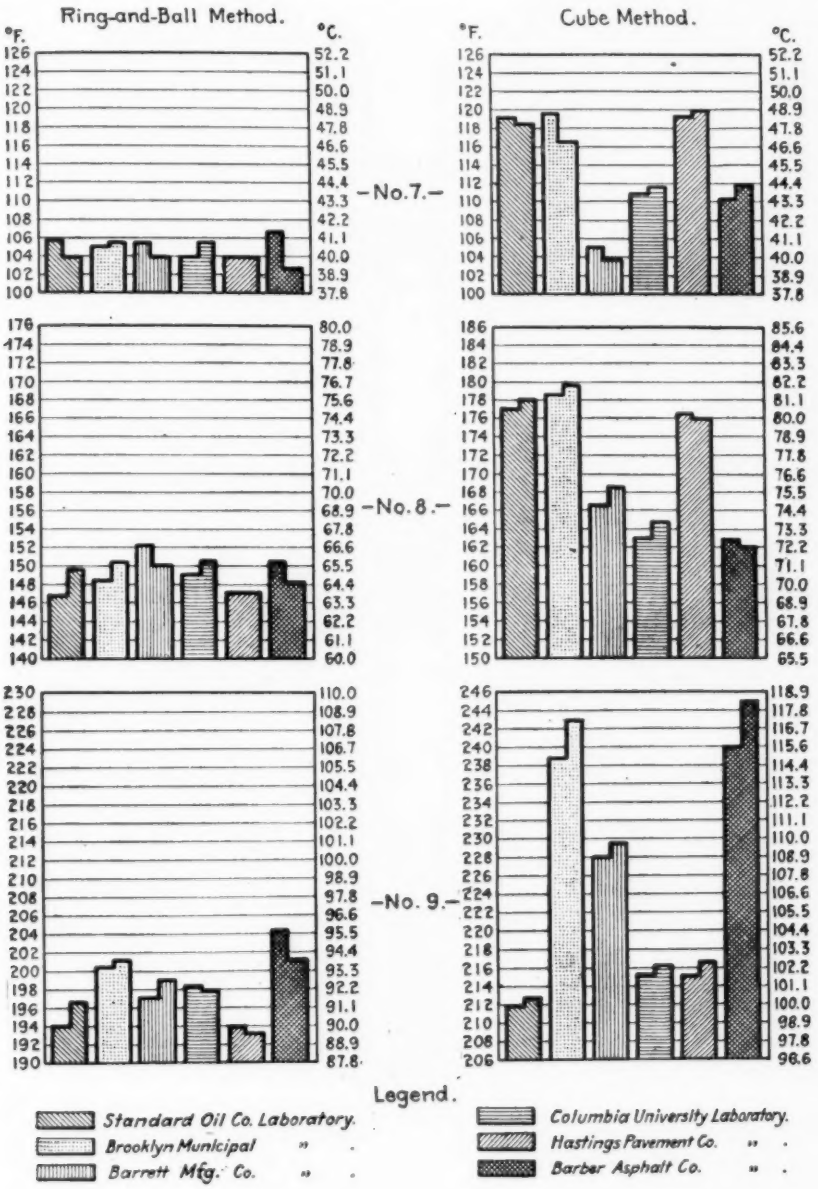

FIG. 3.—Determination of Softening Point on Unblown Oil Asphalts.

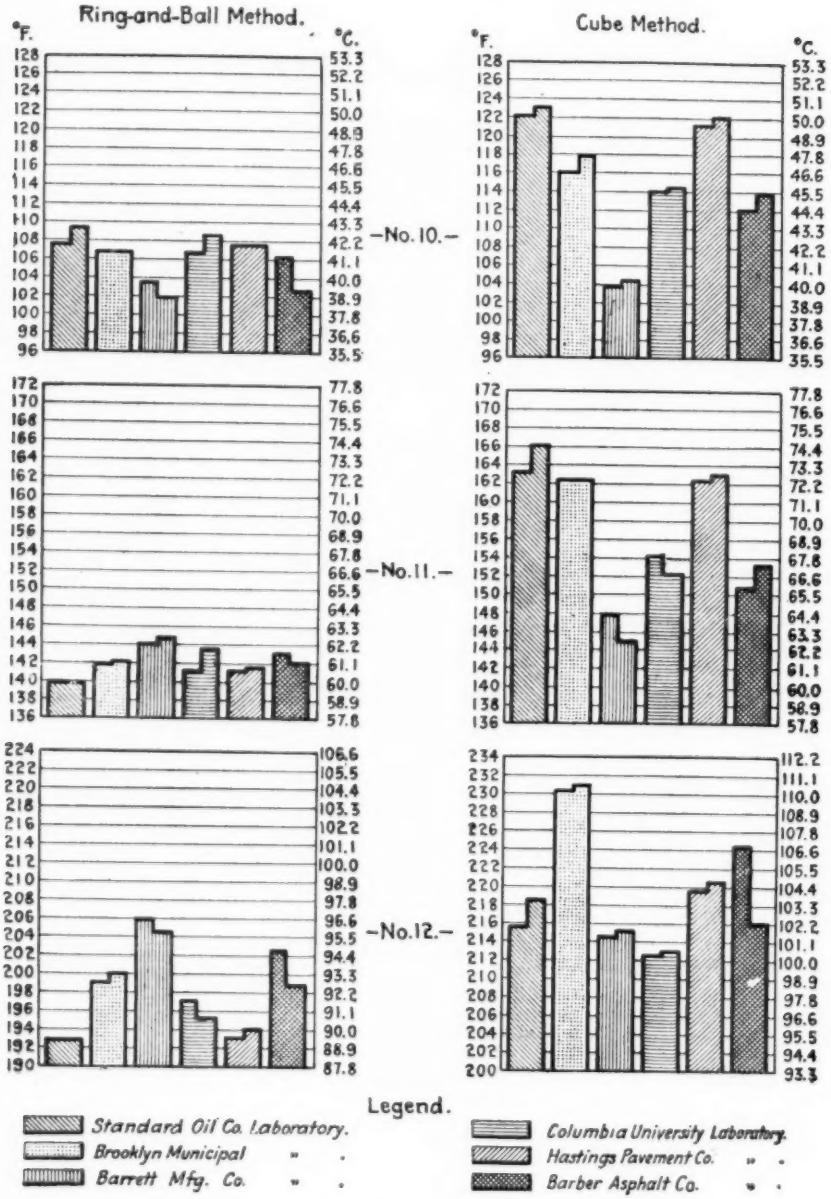

FIG. 4.—Determination of Softening Point on Native Asphalt Products.

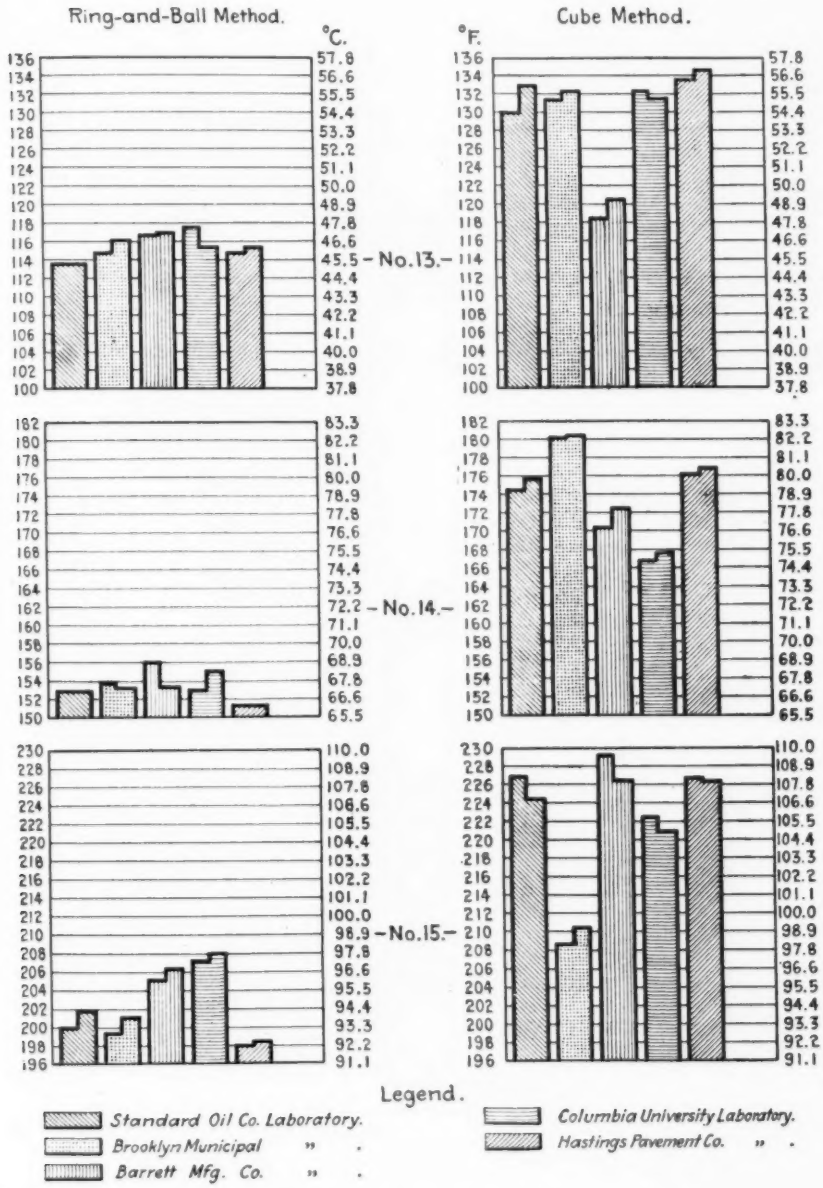

FIG. 5.—Determination of Softening Point on Unblown Oil Asphalts.

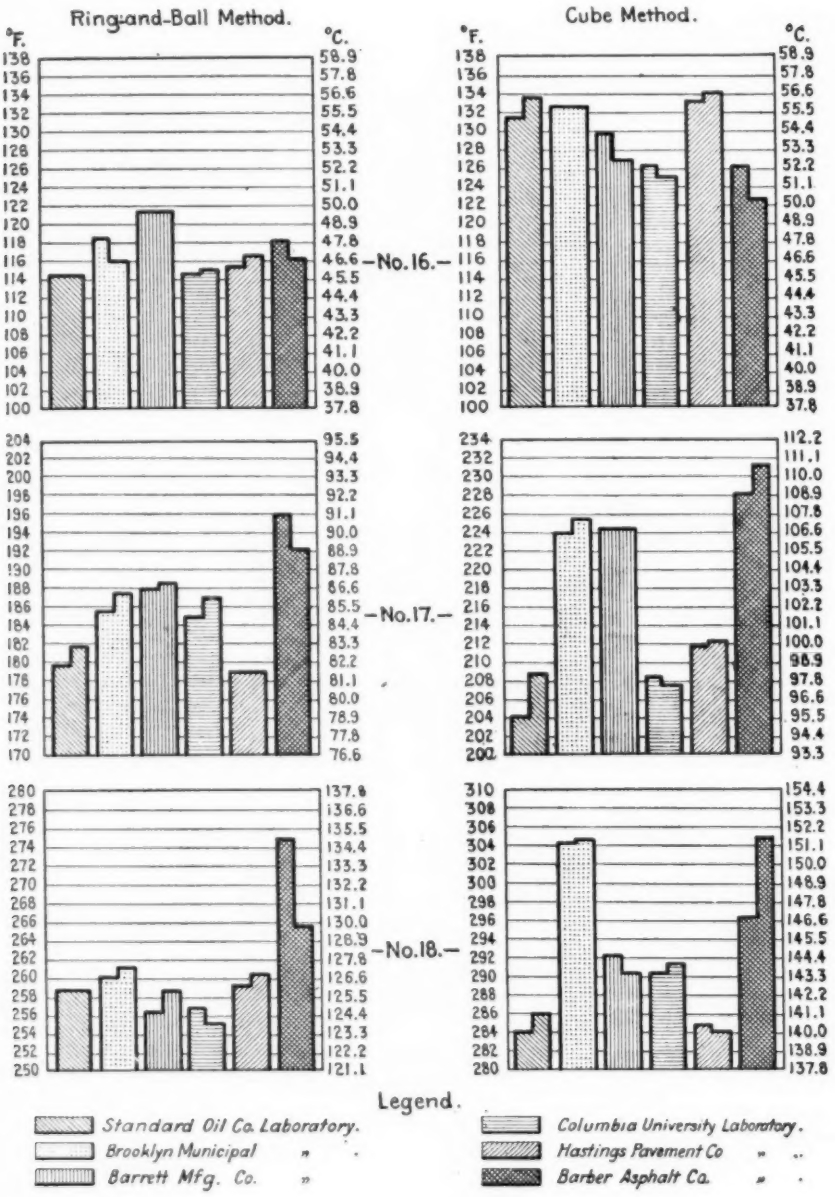

FIG. 6.—Determination of Softening Point on Air-Blown Oil Asphalts.

APPENDIX IV.

REPORT OF SUB-COMMITTEE ON DUCTILITY TESTS.

The normal ductility of a bitumen is the distance expressed in centimeters that a briquette will stretch before breaking when tested under standard conditions.

The standards usually employed with the test are as follows:

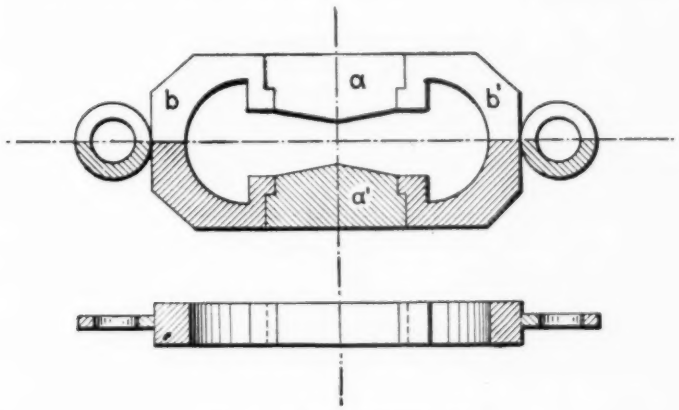

FIG. 1.—Dow Ductility Mold.

Mold.—The mold to be used for the briquette of bitumen is shaped as shown in Fig. 1. Its dimensions are as follows:

Total length (internal)	7.5 cm.
Distance between clips	3.0 cm.
Width of clips at mouth	2.0 cm.
Width of briquette at minimum cross-section (half-way between clips)	1.0 cm.
Thickness of briquette throughout	1.0 cm.

The clips containing the briquettes are pulled apart under water kept at 70° F. at a uniform rate of speed of 5 cm. per minute. They may be operated by any means that will give a uniform pull without appreciable vibration, the line of pull to be horizontal.

Some little work was done during the past year in the way of testing standard samples sent to different laboratories. Four

sets of samples were sent to six different laboratories. The samples were selected by the chairman, from materials which were known by him as those on which it was difficult to obtain concordant results in this test. They were prepared with care in his laboratory so as to have the samples of each set as nearly identical as possible. Besides the members of the sub-committee, Dr. Felix Kleeburg, chemist of the Bureau of Highways of the Borough of Manhattan, New York, was kind enough to cooperate in testing these samples.

The directions accompanying the samples were as follows:

Six briquettes from each sample should be pulled for ductility, pulling three of these at a time if the machine is so constructed. The sides of the mold may be either amalgamated or chalked, but please report which method is used. Make note of the way in which the molds were filled. Give accurate measurements of the different molds used, stating distance between clips, thickness of mold, width of smallest cross-section, width at clip and length-over-all internal measurement.

The asphalt sample must be melted by placing it in a hot-air oven heated to a temperature not exceeding 310° F. The sample must be thoroughly melted and well stirred, and at the time of pouring into the mold must be at a temperature between 290 and 300° F. (actual temperature of sample). The sample must not remain in the hot-air oven in a melted condition more than one hour. In filling the mold with the melted asphalt, pour in a steady stream into the center of the mold, allowing it to flow both ways into the wider parts of the mold. When as much asphalt has been poured as will more than fill the center portion of the briquette, the two ends of the mold may be filled, if necessary, by pouring asphalt into them. Allow the briquettes to cool in the laboratory at a temperature above 60° F. When they are sufficiently cool they must be leveled off in the mold by cutting off excessive asphalt with a hot putty knife. While this leveling is being done the center portions of the mold must be squeezed together as tight as possible by hand so as to prevent them being forced out by the cutting. After this, the sides of the mold may be removed and the sample placed in water and kept within 1° of a temperature of 77° F. for at least one hour, and not longer than two hours. At the end of this time the three samples should be placed in the machine and tested for ductility by pulling apart at the rate of 5 cm. per minute.

Please make note of time when sample was placed in the hot-air oven and when it was removed and poured into mold; also the time when cut and placed in water at the standard temperature, and the length of time it remained in this water before testing. Note also temperature variation of water in standard bath and also in tank of machine while test was being made.

The results obtained are given in Table I.

In one or two cases where the ductility of the sample deter-

mined by any laboratory varied materially from that obtained in the laboratory of the chairman, the sample was investigated. In two cases, these variations were shown to be due to differences in the samples and not to conditions in the method of manipulation. The results, as will be seen, are not as concordant as are desirable, but these variations are now under investigation and we are in hopes of finding out where the difficulty lies.

It must also be borne in mind, as above stated, that only such samples were sent out on which it appeared difficult to

TABLE I.—RESULTS OF TESTS FOR DUCTILITY.

Sample No.	Ductility Determined by Different Observers, centimeters pulled before rupture.					
	Kershaw.	Gage.	Broadhurst.	Pullar.	Kleeburg.	Dow.
10923 (Test A)	55	49	36[a]	..	53	52
	58	46	36	49	52	53
	82	48	42	52	48	57
10923 (Test B)	51	54	35	..	46	48
	59	48	35	..	53	60
	75	44	36	..	48	69
11020	26	24	22	..	22	20
	30	26	28	..	22	21
	30	24	21	..	23	24
	23	25	..	..	23	24
	28	23	..	..	24	24
	39	..	..	..	17	21
11018	68	45	76	..	39	78
	70	52	66	..	37	77
	68	46	56	..	32	73
	45	44	..	..	34	78
	50	..	..	..	33	77
	54	..	..	..	34	..
10923	52	40	61	..	31	62
	54	41	60	..	32	46
	66	46	44	..	40	60
	39	43	..	..	34	47
	54	..	..	..	36	47
	67	..	..	..	38	52

[a] This sample was checked by Dow, who obtained the same results as Broadhurst, showing that the sample was lower in ductility than those sent to the other observers.

obtain concordant results. There are many classes of materials which will give the same ductility time after time. From investigations carried on so far by the chairman, it would appear that this lack of concordance in ductility on different samples is due to some physical change which takes place in the sample.

Respectfully submitted on behalf of the Sub-Committee on Ductility Tests,

A. W. Dow,
Chairman.

APPENDIX V.

REPORT OF SUB-COMMITTEE ON PENETRATION.

At a meeting held in September, 1914, ample evidence was secured of the unsatisfactory status of the apparently simple test for penetration of bitumen, and the need of a more definite method to replace the present one[1] adopted by the Society in 1911.

It was realized, however, that it would be impossible to devise a universal method that would prove suitable under all conditions. Paving plants, refineries, etc., on the one hand, demand rapid and more or less approximate tests, while on the other hand, inspecting laboratories are in a position to afford to the determination the necessary time for greater accuracy. It was decided, therefore, to limit efforts to the determination of an arbitration method, leaving its relation to the different routine procedures to be ascertained by the individual operators concerned.

It was agreed to conduct some of the transactions by correspondence, and the method of Dow and Smith, as given in their booklet of instructions with their penetration machine, was taken as a basis. Each member was to forward to the others his suggestions as to desirable changes, and when these ideas had been exchanged another meeting was to be called.

At the second meeting the ideas of the different members, which coincided to a remarkable extent, were drafted into a definite form. As a result the sub-committee is therefore able to present as a part of this report the following proposed Test for the Penetration of Bituminous Materials.

PROPOSED TEST FOR PENETRATION OF BITUMINOUS MATERIALS.[2]

Definition. 1. The normal "penetration" of bitumen shall be the distance, expressed in hundredths of a centimeter, that a

[1] 1914 Year-Book, p. 344.

[2] Criticisms of this Test are solicited and should be directed, preferably before January 1, 1916, to Mr. Leroy M. Law, Interocean Oil Co., East Brooklyn, Baltimore, Md.

standard needle will penetrate into it vertically, and without appreciable friction in the apparatus, at 25° C., under a load of 100 g. applied for five seconds.

APPARATUS.

Container. 2. The container for holding the material to be tested shall be a flat-bottom, cylindrical dish 55 mm. ($2\frac{3}{16}$ in.) in diameter and 35 mm. ($1\frac{3}{8}$ in.) deep.[1]

Needles. 3. The needles for this test shall be R. J. Robert's Parabola "Sharps" No. 2. They shall be carefully selected by the use of a hand glass, rejecting all that are manifestly of unusual shape or taper. Needles thus selected shall be compared with a standard needle[2] and further rejections made of those which vary more than one point from that obtained with the standard needle, on a sample having a penetration of approximately 60.

Water Bath. 4. The water bath shall be maintained at a temperature not varying more than 0°.1 C. from 25° C. (77° F.). The volume of water shall be not less than 10 liters and the sample shall be immersed to a depth of not less than 10 cm. (4 in.) and shall be supported on a perforated shelf not less than 5 cm. (2 in.) from the bottom of the bath.

Instrument. 5. Any apparatus which will allow the needle to penetrate without appreciable friction, and which is accurately calibrated to yield results in accordance with the definition of penetration, will be acceptable.

Transfer Dish for Container. 6. The transfer dish for container shall be a small dish or tray of such capacity as will insure complete immersion of the container during the test. It shall be provided with some means which will insure a firm bearing and prevent rocking of the container.

METHOD.

Preparation of Sample. 7. The sample shall be completely melted at the lowest possible temperature and stirred thoroughly to insure complete

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[1] This specification is fulfilled by the American Can Company's Gill Style ointment box, deep pattern, 3 oz. capacity.

The committee does not think it advisable to recommend at the present time, a standard needle for reference, deferring such action until the next annual meeting of the Society. Until such recommendation is made, needles furnished with penetration machines are to be considered standard.

homogeneity. It shall then be poured into the sample container to a depth of not less than 30 mm. ($1\frac{3}{16}$ in.). The sample shall be protected from dust and allowed to cool in an atmosphere not lower than 65° F. for one hour. It shall then be placed in the water-bath, along with the transfer dish, and allowed to remain one hour.

Testing. 8. In making the test the sample shall be placed in the transfer dish filled with water from the water bath of sufficient depth to completely cover the container. The transfer dish containing the sample shall then be placed upon the stand of the penetration machine. The needle, loaded with the specified weight, shall be adjusted to make contact with the surface of the sample. This may be accomplished by making contact of the actual needle point with its image reflected by the surface of the sample from a properly placed source of light. Either the reading of the dial shall then be noted or the needle brought to zero. The needle is then released for the specified period of time, after which the penetration machine is adjusted to measure the distance penetrated.

At least three tests shall be made at points on the surface of the sample not less than 1 cm. ($\frac{3}{8}$ in.) from the side of the container and not less than 1 cm. ($\frac{3}{8}$ in.) apart. After each test the sample and transfer dish shall be returned to the water bath and the needle shall be carefully wiped toward its point with a clean dry cloth to remove all adhering bitumen. The reported penetration shall be the average of at least three tests whose values shall not differ more than four points between maximum and minimum.

When necessary to vary the temperature, time and weight, and in order to provide for a uniform method of reporting results when variations are made, the following combinations are suggested:

At 0° C. (32° F.), 200-g. weight, 1 minute.
At 46° C. (115° F.), 50-g. weight, 5 seconds.

It will be noted that this method is founded on the present type of needle, namely the Robert's No. 2 Parabola "Sharps," but this is not considered ideal in the opinion of the sub-com-

mittee. On account of the time and work which would be required to devise a new needle and one that would be in harmony with present conceptions as to consistencies, the sub-committee deems it advisable to let this feature remain as its work for the coming year.

This report is practically unanimous on the part of the Sub-Committee on Penetration, the only exception being in the case of one member who is abroad and was unable to participate in our final meeting. The penetration test is one of the most important determinations on bituminous materials and the chaotic conditions which to-day surround it have caused an urgent need for some standard procedure. I trust, therefore, that our efforts in this direction will receive the approval of the Sub-Committee I, the full committee and the Society.

In conclusion, permit me to express my thanks to the members of the Sub-Committee on Penetration, all of whom, though extremely busy with a multitude of regular duties, have nevertheless sacrificed some of their valuable time in the interest of this work.

Respectfully submitted on behalf of the Sub-Committee on Penetration,

LEROY M. LAW,
Chairman.

DISCUSSION.

Mr. Muer. MR. HENRY F. MUER (*by letter*).—The committee recommends in its report "that the Jackson specific gravity apparatus be used for the determination of the specific gravity of sand and fine aggreates." We (Mt. Prospect Laboratory, City of New York) find that this apparatus gives results about 4 per cent low in cement work in comparison with other methods, due to wrong calibration by the makers. The same error was found also by Mr. Meade. We obtain the best results by the method devised by Mr. Gottsch of this laboratory, described in the Journal of Industrial and Engineering Chemistry, Vol. 1, page 207.

Mr. Page. MR. L. W. PAGE (*Chairman of Committe D-4—Closure by letter*).—With reference to Mr. Muer's criticism, relative to the use of the Jackson specific gravity apparatus, as recommended in the above report of Committee D-4, I beg to say that his criticism has been brought to the attention of that committee, and that it has been referred to a special sub-committee for consideration and report, in due course, to the main committee.

REPORT OF COMMITTEE D-5

ON

STANDARD SPECIFICATIONS FOR COAL

As reported at the Sixteenth Annual Meeting of this Society, in 1913, Committee D-5, following its appointment in 1909, was divided into several sub-committees, each charged with considering the subject of specifications for the purchase of coal for particular purposes, as steaming and power-plant use, household and domestic use, gas making, etc. The members of the several sub-committees, except the sub-committee on the specifications for coal for steaming and power-plant purposes, agreed as a result of their endeavors that existing knowledge was inadequate as a basis for satisfactory specifications.

Much more work has been done on the specifications for coal to be used for steaming and power-plant purposes, and important progress has been made, based on actual experience as well as on laboratory work, toward the framing of satisfactory specifications for such coal. A few details, however, especially those relative to the methods of sampling the coals to be purchased under the specifications, had not been worked out to the satisfaction of a majority of the members of the committee.

After the committee had reported to the Society in 1913, the various sub-committees were united into a general committee. This committee has given serious consideration to the preparation of standard specifications for the purchase of coal used for steaming and power-plant purposes, much work having been done by the individual members as well as by the committee at its meetings.

After a full discussion of the subject at a meeting on April 18, 1914, the consensus of opinion was that, as the purchase of coal under specifications is in a state of evolution and development, and as experience and time are required to develop stand-

ards, the time had not yet arrived for the preparation of standard specifications.

At a meeting held on January 9, 1915, the committee decided to confine its discussions and action for the time being to the development of a method of sampling coal. Accordingly, and as a result of the work of the committee to date, a proposed Method for Sampling of Coal has been prepared and is appended hereto,[1] with the recommendation that it be printed in the Year-Book for one year as tentative.

The committee considers that through the preparation of a tentative method of sampling coal, real and substantial progress will be made towards the preparation of standard specifications for the purchase of coal. The success of any method of purchase under specifications depends on sampling. If the sampling is improperly done, the analyses are unreliable, controversies ensue, the specification method is discredited, and the development of standard specifications is retarded. By the preparation of a method of sampling, the committee believes it has paved the way for continuing its efforts which may ultimately result in the preparation of standard specifications.

This report has been submitted to letter ballot of the committee, which consists of 34 members, of whom 23 have voted affirmatively, 3 negatively, and 8 have refrained from voting.

Respectfully submitted on behalf of the committee,

J. A. HOLMES,
Chairman.

G. S. POPE,
Secretary.

[EDITOR'S NOTE.—For action taken on this report, see pages 14–15.

The proposed Tentative Standard referred to in the report appears among the Tentative Standards in the 1915 Year-Book.]

[1] This method is not reprinted here, but it appears in the 1915 Year-Book.—ED.

REPORT OF COMMITTEE D-6

ON

STANDARD SPECIFICATIONS FOR COKE.

It will be noted that in 1912 this committee reported to the Society that conditions at that time were such as "to prevent the formulation of definite standard specifications for bee-hive and by-product coke, covering any wide scope," and that the committee purposed to direct its work along four lines, namely: (1) Method of sampling coke; (2) standard methods of chemical analysis; (3) standard methods for the physical testing of coke; and (4) standard specifications for foundry coke.[1]

Since 1912 the committee has held several meetings, and in addition some of the individual members have been working along the lines indicated above, so that the committee is now able to submit the appended Tentative Specifications for Foundry Coke with the recommendation that they be printed in the Year-Book.[2]

Owing to the wide variation in the physical and chemical requirements of coke used for various purposes, the committee has limited its present work to coke used for foundry purposes, and has considered the methods of sampling, analysis and testing, and the form of the specifications, with special reference to the conditions under which foundry coke is sold.

1. *Method of Sampling.*—It was recognized that a rational and accurate method of sampling coke should involve taking regular increments while loading or unloading the car, so as to secure several hundred pounds of gross sample, which should then be reduced by suitable methods of crushing, mixing and quartering to a convenient size for transportation to the laboratory. Such a method of sampling, however, presents several practical difficulties, namely: (1) The crushing and reduction of several hundred pounds of coke necessitates the use of mechanical

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XII, p. 78 (1912).

[2] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—Ed.

crushers, which are seldom available at the point of sampling; and (2) sampling while unloading the coke is feasible only when the coke is purchased under a system of premiums and penalties, which system, according to the experience of the committee, the trade is not willing to accept at this time.

Since the only acceptable form of specification is one based on maximum and minimum limits of chemical composition with the privilege of rejection when these limits are exceeded, it seemed essential to take the sample from the exposed surface of the car so that the car could be rejected before unloading in case the coke did not conform to the specifications.

The committee recognized that a minimum gross sample of 2 pecks of walnut size is too small to be strictly representative; however, in view of the fact that a sample taken from the top of a car is only approximately representative of all the coke, it seemed unnecessary to impose the extra expense entailed by crushing down a larger sample.

2. *Standard Methods of Chemical Analysis.*—Satisfactory progress has been made toward the adoption of uniform standard methods of analyzing coke, by cooperation with the joint committee on coal analysis of the American Chemical Society and the American Society for Testing Materials, and the committee on coke analysis of the American Foundrymen's Association, and it is expected that uniform standard methods will be available for incorporation in coke specifications by the end of another year.

3. *Standard Methods for the Physical Testing of Coke.*—The committee has given considerable attention to the various physical tests of coke, such as crushing strength, shatter test, porosity, specific gravity, etc., and as a result of this investigation concludes that the compressive-strength test as determined on 1-in. cubes is worthless as a means of comparing different cokes,[1] and that in general the relation between results of physical tests of coke and its value in practical use is too indefinite to include quantitative expressions of physical properties in standard specifications at present.

The committee asks to be continued in order to further investigate the question of the physical testing of coke, and the

[1] Belden, "Metallurgical Coke," *Technical Paper No. 50*, Bureau of Mines, p. 40 (1913).

development of a more complete standard specification for foundry coke.

This report has been submitted to letter ballot of the committee, which consists of 17 members, of whom 12 have voted affirmatively, 1[a] negatively, and 4 have refrained from voting.

Respectfully submitted on behalf of the committee,

J. A. HOLMES,
Chairman.

A. C. FIELDNER,
Secretary.

[EDITOR'S NOTE.—For action taken on this report, see page 15.

The proposed Tentative Standard referred to in the report appears among the Tentative Standards in the 1915 Year-Book.]

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[a] This member approves the report and proposed specifications with the exception of the limits assigned to volatile matter and fixed carbon.

REPORT OF COMMITTEE D-7

ON

STANDARD SPECIFICATIONS FOR TIMBER.

Committee D-7 has held two meetings during the past year, and there were numerous meetings of sub-committees. Since a number of the sub-committees had new subjects assigned to them, no reports are available for some of the sub-committees, and only progress reports for some of the others.

Sub-Committee I on Classification and Designation of Southern Yellow Pines.—Sub-Committee I carried on a study started by the committee as a whole several years ago, for the purpose of developing specifications which will do away with the confusion incident to the present nomenclature of southern yellow pines. As pointed out by Committee D-7 in 1909,[1] the classification of the southern yellow pines as longleaf, shortleaf, loblolly, Cuban and pond pines, while satisfactory from a botanical standpoint, cannot be commercially applied, owing to the fact that timbers cut from the various pines intergrade more or less. Furthermore, owing to the fact that no definite physical method has yet been found whereby one can readily and conveniently distinguish the timber of the different species, the committee accordingly suggested in 1909 that the southern yellow pines be graded according to the number of rings per inch, irrespective of botanical species. Investigations carried on by the United States Forest Service during the last few years have indicated that the basis of classification suggested by the committee in 1909, was not clear enough and could not be depended upon as a basis for structural requirements. During the last year the Forest Service conducted a very extensive series of investigations to determine the relationship between the number of rings per inch, the percentage of summer wood, the degree of contrast between the summer and spring wood, and the strength.

After having given careful consideration to the results obtained by the Forest Service and to the series of specifications proposed by various organizations of pine manufacturers, the

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. IX, p. 286 (1909).

committee adopted the suggested specification proposed by the United States Forest Service, with some slight modification, and presents these specifications herewith for adoption as standard. It will be noted that two classes of pine are made, namely, "dense" pine and "sound" pine. It should be clearly understood that these terms take the place of the usual designations of longleaf, shortleaf, loblolly, etc. In other words, the terms are descriptive of quality, irrespective of botanical species.

Through the courtesy of the Forest Service the committee is enabled to present in Appendices II and III to this report two papers which fully explain the reasons why a density rule, such as is proposed, appears to be a desirable one.

The committee accordingly recommends that the following two revisions be referred to letter ballot of the Society:

1. The revisions in the Standard Classification of Structural Timber (Serial Designation: D 9–07),[1] given in Appendix I to this report;

2. Proposed revised Standard Specifications for Yellow-Pine Bridge and Trestle Timbers, appended hereto,[2] to replace the present specifications (Serial Designation: D 10–10).[3]

Consideration was given by the committee to the method of measuring the actual density of the wood and the resin content from samples bored from a stick. It was voted to present as information to the Society that, in the opinion of the committee, such methods may be used in special inspection when the timber is to be used for special service.

The following methods of measuring actual density and resin content are recommended to be used when called for in special inspection:

Three borings shall be taken from a cross-section to the grain by an auger 1 in. in diameter. The borings shall be dried, weighed, and the density computed from this weight and the volume of the auger hole. The percentage of resin shall be determined from similar borings which have been dried, and the resin extracted with benzol. The extracted resin shall be evaporated until it is not soft or sticky when touched with the finger at 70° F.

[1] 1914 Year-Book, p. 348.

[2] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

[3] 1914 Year-Book, p. 352.

Sub-Committee II on Uses of Untreated Yellow Pine.—This sub-committee presents as information the following progress report:

It is unnecessary to point out the great importance of this subject to both the manufacturers and consumers of lumber. The extreme difficulty of accomplishing tangible results in one year's work by a voluntary sub-committee, is also obvious.

In the outline prepared for the compilation of information from various sources it was stated as follows:

"The yellow-pine manufacturers and wholesalers should be the source of information regarding the availability of grades and the feasibility of suggested changes. They should also be vitally interested in furnishing the ultimate consumer the kinds and grades of lumber best fitted to his requirements. Failures of yellow pine are too often due to the use of various grades for purposes to which they are not adapted.

"Substitutes are demanded when wood fails to meet the requirements, and because manufacturers of substitutes promote their products."

The sub-committee has not been able to hold a meeting, and it has been further handicapped by the uncertainty as to the grading rules for yellow pine, which will ultimately be adopted. On the assumption that the structural grades now under consideration will be adopted, it seemed inadvisable to work up details covering the uses of yellow pine in relation to the grading rules of 1905, or others which might be in use. The sub-committee can merely report progress at the present time, and state that with the adoption of definite structural grades it will be able to go ahead and compile information on the subject assigned.

The following outline has been in the hands of the members of the sub-committee for some time, and with such modifications as are required to meet conditions which arise, may be considered the basis for future work:

1. The suitability of different grades of yellow pine for specific purposes.

(*a*) The selection of grades in relation to the ultimate use of timber, including consideration of resistance to decay, strength, clearness and soundness.

2. The requirements of timbers for certain uses.

(*a*) To what extent and why certain grades meet certain requirements;

(*b*) Consideration of the actual requirements in relation to cost and grades.

3. Determination of conditions under which to use treated or untreated yellow pine.

(*a*) Suitability of various grades for treatment;

(*b*) Kinds of treatment in relation to service requirements.

4. Availability of specified grades for stated requirements.

(*a*) Character of timber available and grades into which it can be manufactured;

(*b*) Correlation of the consumer's actual ultimate requirements with the manufacturer's output;

(*c*) The wholesaler's responsibility in meeting the consumer's requirements for the timbers available.

Sub-Committee V on Methods of Preservative Treatment of Timber.—This sub-committee presents for consideration and criticism (1) Tentative Specifications for Southern Yellow-Pine Timber to be Creosoted and (2) Tentative Specifications for Southern Yellow-Pine Piles and Poles to be Creosoted. These are appended to this report, with the recommendation that they be printed in the Year-Book for one year.[1]

Sub-Committee VI on Timber Preservatives.—This sub-committee presents as information the following report:

In accordance with instructions the sub-committee communicated with the Committee on Wood Preservatives of the American Railway Engineering Association, and received a formal request that it endorse their specifications as published in their Manual at the present time. Communication with the Chairman of the Committee on Preservatives of the American Wood Preservers' Association also ensued, with the result that he was present at both of our sub-committee meetings. The National Electric Light Association has been invited to appoint a delegate to cooperate with us, inasmuch as they have no standing committee on timber preservation. The sub-committee has also communicated with the Chairman of the Committee on Wood Paving Blocks of the American Society for Municipal

[1] These specifications are not reprinted here, but they appear in the 1915 Year-Book.—ED.

Improvements, and that committee has signified its intention to cooperate.

The sub-committee has prepared Tentative Methods for Sampling and Analysis of Creosote Oil, appended to this report, and recommends that they be printed in the Year-Book for one year.[1]

A discussion of the methods of sampling of zinc chloride did not result in any definite recommendation, and this question will be further investigated.

The methods of analysis of creosote oil are a revision of the form and wording of the methods of analysis of creosote oil as adopted by the American Railway Engineering Association, and refinement of the technique of their methods, without changing their requirements or essential details.

Sub-Committee VIII on Fireproofing of Timber.—This sub-committee has been investigating various tests for building fire retardants, both for exterior and interior work. Their chief endeavor has been to develop a standard apparatus for determining the comparative inflammability of the various species of untreated wood and wood treated with various chemical compounds. It is expected that next year the sub-committee will be in position to recommend a standard method.

This report has been submitted to letter ballot of the committee, which consists of 32 members, of whom 29 have voted affirmatively, none negatively, and 3 have refrained from voting.

Respectfully submitted on behalf of the committee,

HERMANN VON SCHRENK,
Chairman.

[EDITOR'S NOTE.—For action taken on this report, see pages 29–30.

The proposed amendments in the Standards referred to in the report, as amended at the annual meeting, were adopted by letter ballot of the Society on August 21, 1915. The Standards as amended appear among the Standards in the 1915 Year-Book.

The proposed Tentative Standards referred to in the report appear among the Tentative Standards in the 1915 Year-Book.

For Discussion on the report, see page 402.]

[1] These methods are not reprinted here, but they appear in the 1915 Year-Book.—ED.

APPENDIX I.

PROPOSED REVISIONS IN STANDARD CLASSIFICATION OF STRUCTURAL TIMBER.[1]

The committee recommends that the following revisions of the Standard Classification of Structural Timber (Serial Designation: D 9–07)[2] be referred to letter ballot of the Society for adoption:

1. Change the definition of the term "encased knot," Section 4 of Part II on Standard Defects, to read as follows:

> "4. *Encased Knot.*—An encased knot is one whose growth rings are not intergrown and homogeneous with the growth rings of the piece it is in. The encasement may be partial or complete; if intergrown partially or so fixed by growth or position that it will retain its place in the piece, it shall be considered a sound knot; if completely intergrown on one face, it is a watertight knot."

2. Strike out Section 1, "Southern Yellow Pine," of Part III on Standard Names for Structural Timbers, and substitute the following:

> "1. *Southern Yellow Pine.*—This term includes the species of yellow pine growing in the southern states from Virginia to Texas, that is, the pines hitherto known as longleaf pine (*Pinus palustris*), shortleaf pine (*Pinus echinata*), loblolly pine (*Pinus taeda*), Cuban pine (*Pinus heterophylla*) and pond pine (*Pinus serotina*).
>
> Under this heading, two classes of timber are designated: (*a*) dense southern yellow pine and (*b*) sound south-

[1] The title of this Standard has been changed to "Standard Definitions of Terms Relating to Structural Timber," and appears in revised form in the 1915 Year-Book.—Ed.

[2] 1914 Year-Book, p. 348.

ern yellow pine. It is understood that these two terms are descriptive of quality rather than of botanical species.

(*a*) Dense southern yellow pine shall show on either end an average of at least six annual rings per inch and at least one-third summer wood, or else the greater number of the rings shall show at least one-third summer wood, all as measured over the third, fourth, and fifth inches on a radial line from the pith. Wide-ringed material excluded by this rule will be acceptable, provided that the amount of summer wood as above measured shall be at least one-half.

The contrast in color between summer wood and spring wood shall be sharp and the summer wood shall be dark in color, except in pieces having considerably above the minimum requirement for summer wood.

(*b*) Sound southern yellow pine shall include pieces of southern pine without any ring or summer-wood requirement.

3. Change Section 6, of Part III on Standard Names for Structural Timbers, to read as follows:

6. *Spruce,* to cover Eastern spruce; that is, the spruce timber coming from points east of and including Minnesota.

APPENDIX II.

DISCUSSION OF THE PROPOSED FOREST SERVICE RULES FOR GRADING THE STRENGTH OF SOUTHERN PINE STRUCTURAL TIMBERS.

By H. S. Betts.

It is hardly necessary to go into detail as to the need for better grading rules than are at present in general use. It is quite possible that the members of Committee D-7 have at various times come in contact with rules providing for the grading of timber by saying that it should not contain defects detrimental to its use for the purpose intended. Clauses of this kind obviously leave the rejection or acceptance of the material under consideration entirely to the inspector. While such a condition may turn out satisfactorily, there are many cases where it has not done so, and where injustices have been done both to the producer and consumer. The more definite it is possible to make grading rules, or the closer it is possible to classify structural material, the more satisfactorily it can be used by the engineer and the more likely will be the producer to obtain a reasonable price for his product.

The mixing of timbers varying considerably in strength, of course, makes it necessary for the engineer to design on the basis of the weakest material he is liable to find in the lot and on that basis he is only willing to pay for the weakest material. From the standpoint of both producer and consumer, the advantages of grading rules that give a fairly close strength classification are evident.

The term "commercial longleaf" is one often found in specifications for structural material. That such a term does not guarantee high-quality timber is illustrated in Fig. 1 which shows sections of timbers recently furnished for three different

large jobs in the cities mentioned. That such timber is of poor quality is very evident.

Under present conditions, any grading rules which are practicable must be simple, and such that the timber can be inspected in a reasonable time, in addition, of course, to satis-

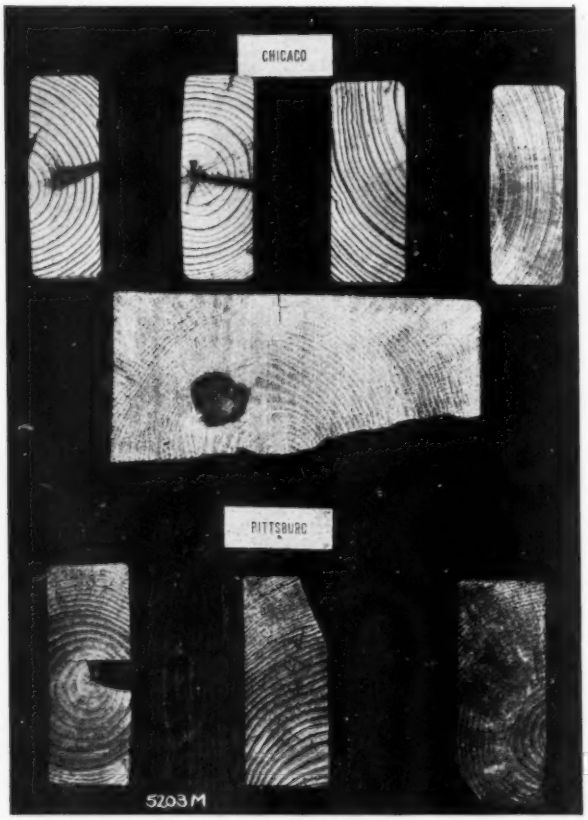


FIG. 1.—Timber on the Market as "Best Quality Longleaf Pine."

factorily dividing the timbers into groups of different strengths. In drawing up rules to cover a higher grade of structural timber than is at present generally supplied on the market, the first condition must be that such rules will exclude practically all material that should not be used in building construction, with

the fiber stress recommended for the grade. The next condition must be that such rules will not exclude more than a reasonable amount of material properly belonging in the grade from the standpoint of strength.

The following rules have been prepared by the Forest Service. It is not claimed that they are above criticism but that they will prove more satisfactory in securing high-grade timber than the rules in general use at present, and will benefit both producer and consumer.

RULES PROPOSED BY THE UNITED STATES FOREST SERVICE FOR GRADING THE STRENGTH OF SOUTHERN YELLOW-PINE TIMBERS; GRADE NO. 1.

Requirements for Density and Rate of Growth.

1. Shall contain only sound wood.

2. Shall show on the cross-section an average of not less than one-third summer wood in timber with six or more annual growth rings to the inch; or one-half summer wood in timber with less than six rings to the inch. The inspection for summer wood and rings shall be made on a radial line from the pith as follows:

1. When the pith is present or can be accurately located.
   (*a*) Radial line of 5 in. present:
      1. Apply inspection over third, fourth, and fifth inches from pith.
   (*b*) Radial line of 5 in. not present.
      1. Apply inspection to the second inch on 2 by 3, 2 by 4, 2 by 6, 3 by 3, 3 by 4, 4 by 4 in., or any other dimension material that has less than 16 sq. in. on the cross-section.
      2. In larger material apply inspection to the three inches farthest from the pith.
2. When the pith is not present or can not be accurately located:
   (*a*) When material is over 3 in. thick apply inspection to three inches nearest the pith.
   (*b*) In dimension material 3 in. or less in thickness apply inspection to second inch from the edge nearest the pith.
3. The radial line chosen shall be representative with respect to rate of growth and percentage of summer wood. In case of disagreement between purchaser and seller the figures obtained by averaging the number of annual rings and percentage of summer wood on the two chosen inspection lines shall be used.

3. Contrast in color between summer wood and spring wood shall be sharp and the summer wood shall be dark in color.

4. It is sufficient if either end passes the inspection.

Restrictions on Knots in Beams.

5. Shall not have in Volume 1 (see Fig. 2) sound knots with a diameter greater than 1½ in. or one-fourth the width of the face on which they appear—or knots over ½ in. in diameter which are insecurely attached to the surrounding wood. Shall not have in Volume 2 sound knots with a diameter greater than 3 in. or one-half the width of the face on which they appear—or insecurely attached knots with a diameter greater than 1½ in. or one-fourth the width of the face on which they appear.

The aggregate diameter of all knots within the center half of the length of any face shall not exceed the width of that face.

The diameter of a knot on the narrow or horizontal face of a beam is to be taken as its projection on a line perpendicular to the edge of the timber. On the wide or vertical face, the smallest dimension of a knot is to be taken as its diameter (see Fig. 2).

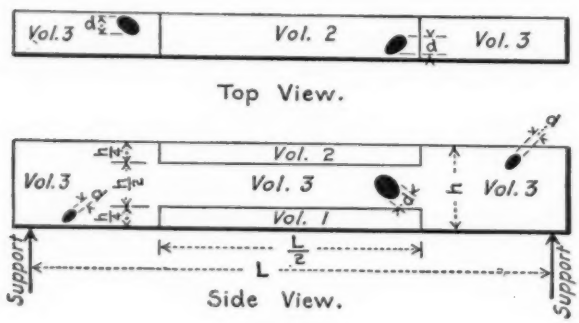


FIG. 2.

Restrictions on Knots in Columns.

6. Shall not have sound knots whose diameters are greater than 4 in. or one-third the least width of the column, or knots over ½ in. in diameter which are insecurely attached to the surrounding wood.

The diameter of a knot is to be taken as its projection on a line perpendicular to the edge of the column—as on the narrow edge of a beam (see Fig. 2).

Restrictions on Shakes and Checks in Beams.

7. Ring-shakes shall not occupy, at either end of a timber, more than one-fourth the width of green material, nor more than one-third the width for seasoned material.

Any combination of checks and shakes which would reduce the strength to a greater extent than the allowable ring-shakes will not be permitted. Shakes shall not show on the faces of either green or seasoned timber.

Restrictions on Cross-Grain in Beams.

8. Shall not have in Volume 1 diagonal grain with slope greater than one in twenty.

NOTES ON PROPOSED RULES.

1. The greater part of southern yellow-pine structural timber is now sold under grade classifications adopted by associations of lumber manufacturers. These classifications differ somewhat and are described in rules published by the several associations. The rules here proposed embody the principles which should guide in the selection of high-grade structural timbers. Their use will result in securing timbers of higher average strength and greater uniformity than can be obtained by the use of any of the existing commercial rules. They are intended to apply to structural timbers only and not to material to be used where factors other than strength are of prime importance. In specifying material the advantages connected with the use of commercial grades should be considered and the commercial grades adhered to as long as it is certain that material selected under such rules will meet the requirements.

2. Contrast in the color of summer wood and spring wood may be classified as sharp, medium, and poor. Sticks with medium or poor contrast should not be admitted in Grade No. 1 material, except when the proportion of summer wood is considerably in excess of the minimum requirement.

3. The importance of shakes and checks in the middle half of the height of a beam is dependent upon the magnitude of the horizontal shearing stress. The specification given is for beams in which the allowable shearing stress is developed. In beams whose length is more than 15 times their height the allowable shearing stress is not usually developed and as the ratio of length to height increases, the importance of these shakes and checks decreases proportionately. Ring-shakes showing on an end should be considered as extending to the center. Checks and radial or star-shakes are not usually continuous in the direction of the length of the timber but should not be allowed if, in the judgment of the inspector, their weakening effect is greater than that of the allowable ring-shakes.

Allowable conditions for both green and seasoned material are given because checks are formed and shakes further developed during seasoning. The maximum amount of shakes and checks should not be allowed unless it is practically certain from the appearance of the timber, or from a knowledge of the seasoning conditions, or length of time elapsed since cutting, that it is thoroughly seasoned. For purposes of this rule, it will be considered that at least 1½ months per inch of thickness is required for material to become thoroughly seasoned.

4. In dry interior construction a working stress of 1600 lb. per sq. in. may be used with beams which meet the requirements of the proposed rules.

Forest Products Laboratory,
Madison, Wisconsin.
April, 1915.

FACTORS THAT GOVERN THE STRENGTH OF TIMBER.

It has been found from extensive series of tests that the strength of wood depends on density, defects and moisture, so that it becomes necessary to find some visual method of classifying timbers according to the degree in which they are influenced by these factors. In formulating the proposed rules, more data

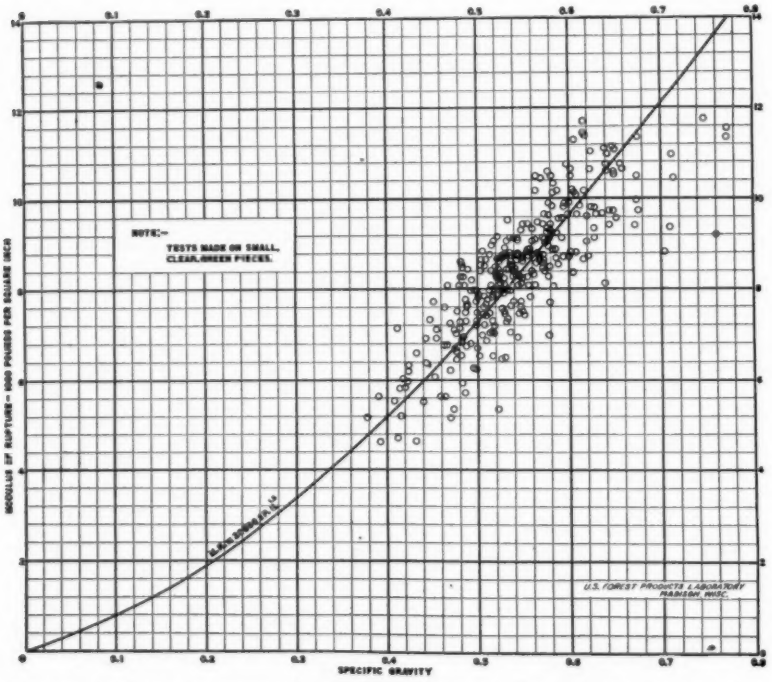


FIG. 3.—Relation between Bending Strength and Dry Weight for Longleaf Pine.

of the kind needed were available for the southern pines than for other structural timbers so that the following remarks apply principally to these pines.

Density.—Fig. 3 shows the relation of specific gravity and strength for longleaf pine. It is evident that as the specific gravity or dry weight increases, the strength also increases in a fairly uniform manner. Density is, however, a factor that can

not be determined from inspection, so it becomes necessary to find some method of estimating it. This is done by making use of the varying proportions of summer wood (hard and dark) and spring wood (light and soft) in the annual rings of different timbers.

In tests made on a number of small pieces of summer wood and spring wood whittled out separately from wide-ring pieces of loblolly pine, the strength and density of the summer wood came very close to being just twice that of the spring wood, so that the percentage of summer wood in the annual rings is an indication of weight and strength.

Another point in connection with estimating density from the proportion of summer wood is the contrast in color between the summer-wood and spring wood. Numerous tests have shown that in the heavier and stronger material, this contrast is sharp; consequently it becomes necessary in drawing up the summer-wood requirements for high-grade material to include also a requirement for sharpness of contrast between summer wood and spring wood, except in cases where the proportion of summer wood considerably exceeds the required minimum. The requirement of one-third summer wood in the annual rings has proved from tests and in trials under commercial conditions to give high-grade material, providing certain requirements as to defects are also satisfied.

In estimating density from summer wood, it would be manifestly impracticable from the standpoint of time for an inspector to consider the whole cross-section in the larger-size timbers. It would also be impossible in a large number of cases for him to accurately estimate summer wood in the outer portions of the piece on account of the fineness of the rings. To get around this difficulty, it was decided to use for estimating summer wood the zone including the third, fourth, and fifth inches from the center. This portion of the timber is the most easily measured or estimated and proved to be very representative of the entire cross-section.

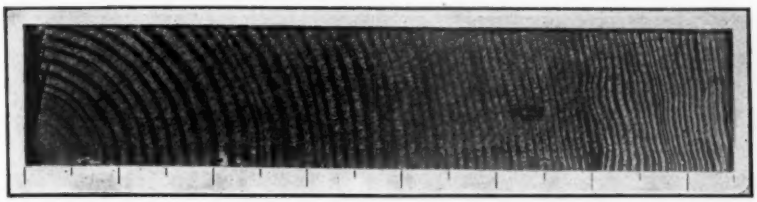
Measurements were made on some 200 trees selected from various places in the southeast. The proportion of summer-wood in the third, fourth, and fifth inches averaged about the same as the proportion of summer wood in the whole cross-

section and few cases showed any marked difference, so it is apparently entirely just to use the third, fourth, and fifth inches from the center as a criterion of the cross-section of the entire stick. The density requirement for first-grade material then becomes one-third summer wood in the third, fourth and fifth inches from the center. The modifications for this requirement in the grading rules are to cover cases where the center is not contained in the stick or where the material is of comparatively small cross-section.

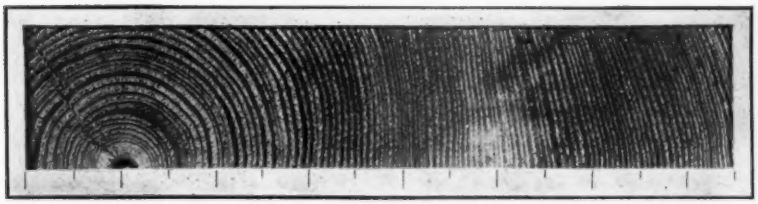
Figs. 4, 5 and 6 show pieces of longleaf, shortleaf, and loblolly pine accepted and rejected under the density requirements. They also show something of the range of quality which it is possible to secure in these species. Figs. 7 and 8 illustrate the application of the density requirement to various forms and sizes.

Defects.—The influence of knots, checks, shakes, and crooked grain on the strength of structural timber has been discussed at some length in several Forest-Service publications, and will not be taken up in detail at this time. The most dangerous knots in the beam from the standpoint of strength are those on the lower side near the middle of the span. The next most dangerous knots are those on the upper side near the middle of the span. Knots along the center line of the height of the beam in general have but little effect on the strength. Checks and shakes have a greater or less weakening effect according to their proximity to the center horizontal plane, due to their tendency to weaken the ability of the beam to resist horizontal shear. The effect of crooked grain on the strength, of course, depends on its degree, and like knots it is most serious near the center of the beam on the lower side.

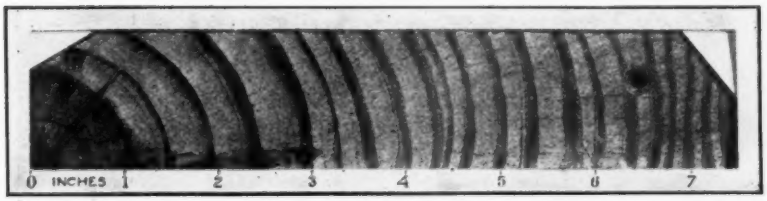
Moisture.—The effect of moisture on strength of small clear pieces is, as is well known, very marked. However, in large timbers ordinarily used for structural purposes, the checks and shakes generally induced in the drying process frequently offset any increase in the strength of the wood itself, so that in any heavy structural material it is not considered good practice to allow higher stresses for dry than for green material.



Accepted.
46 per cent summer wood, 9 rings per inch.



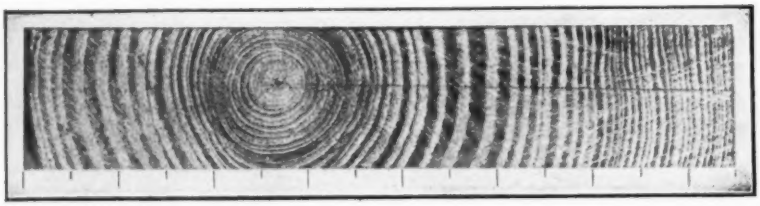
Accepted.
45 per cent summer wood, 16 rings per inch.



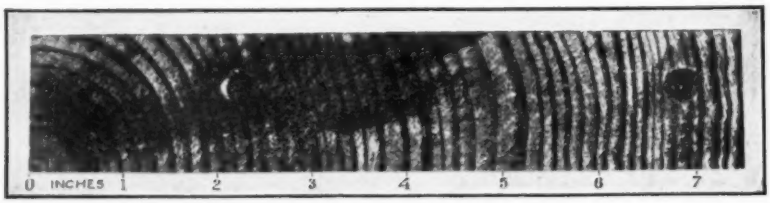
Rejected.
29 per cent summer wood, 3 rings per inch.

Rejected.
24 per cent summer wood, 13 rings per inch.

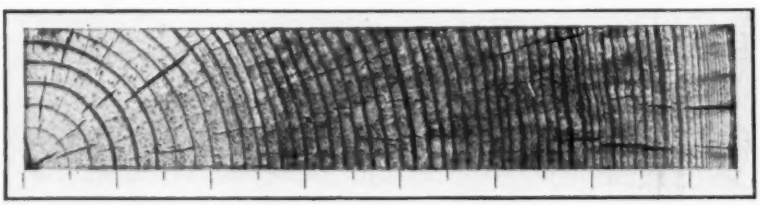
FIG. 4.—Longleaf Pine Accepted and Rejected under Density Requirements.
The percentage of summer wood and the number of rings per inch are given for the third, fourth and fifth inches from the pith.



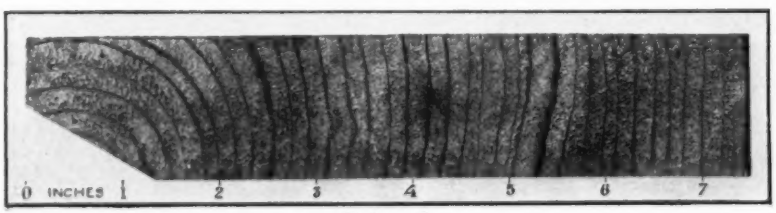
Accepted.
51 per cent summer wood, 12 rings per inch.



Accepted.
38 per cent summer wood, 6 rings per inch.



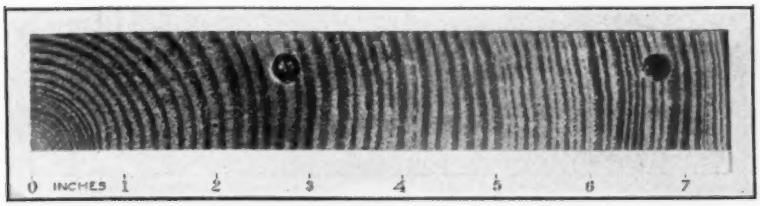
Rejected.
26 per cent summer wood, 7 rings per inch.



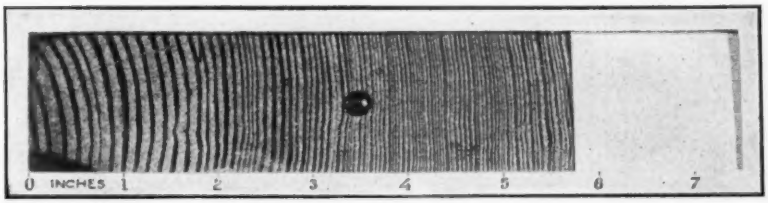
Rejected.
10 per cent summer wood, 5½ rings per inch.

FIG. 5.—Shortleaf Pine Accepted and Rejected under Density Requirements.

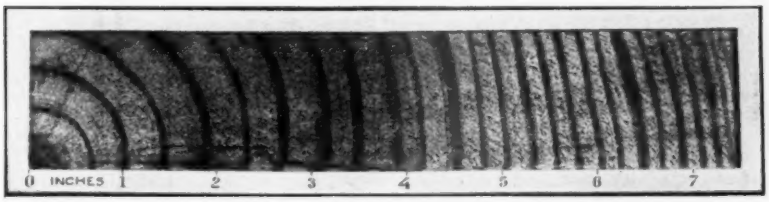
The percentage of summer wood and the number of rings per inch are given for the third, fourth and fifth inches from the pith.



Accepted.
40 per cent summer wood, 7 rings per inch.



Accepted.
34 per cent summer wood, 13 rings per inch.

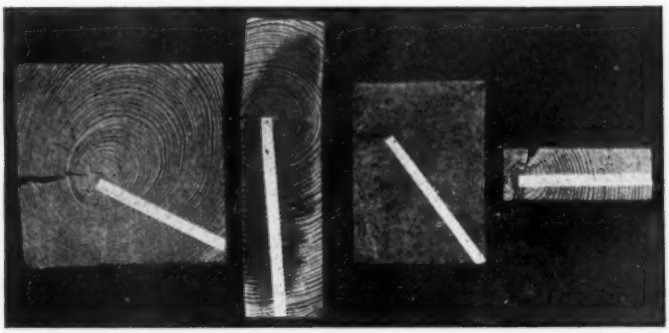


Rejected.
30 per cent summer wood, 3 rings per inch.

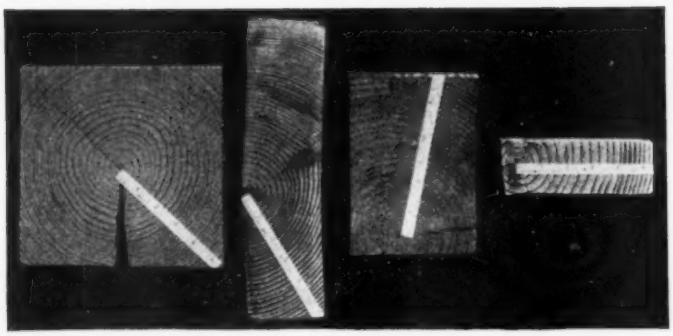
Rejected.
23 per cent summer wood, 10 rings per inch.

FIG. 6.—Loblolly Pine Accepted and Rejected under Density Requirements.
The percentage of summer wood and the number of rings per inch are given for the third, fourth and fifth inches from the pith.

Accepted.



Rejected.



1. Pith Present or Accurately Located.

(*A*) Radial line of 5 in. present:

Apply inspection over third, fourth and fifth inches.

Accepted.

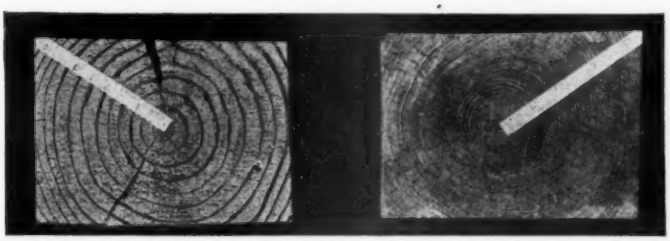
Rejected.

(*B*) Radial line of 5 in. not present:

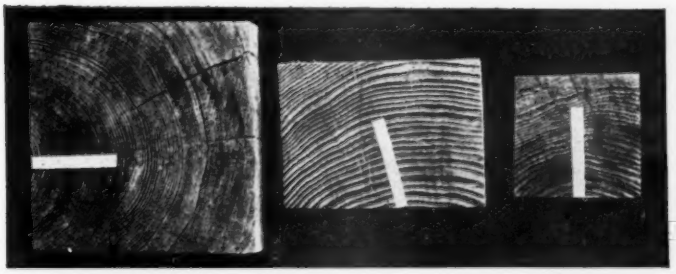
(*a*) Apply inspection to second inch on any dimension material that has less than 16 sq. in. on the cross-section.

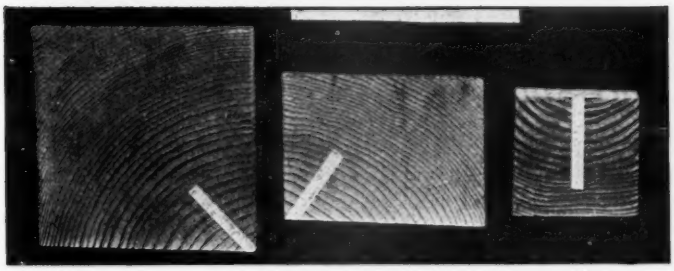
(*b*) See next page.

FIG. 7.—Application of Density Requirements.



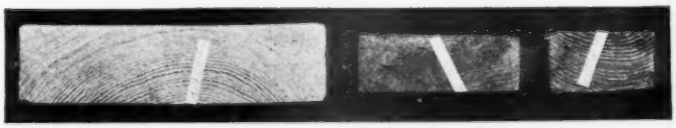
(*b*) In larger material, apply inspection to three inches farthest from pith.

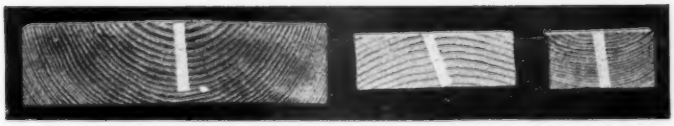




2. Pith not Present, or can not be Accurately Located.

(*A*) In material over 3 in. thick, apply inspection to three inches nearest pith.





(*B*) In dimension material 3 in. or less in thickness, apply inspection to second inch from edge nearest pith.

FIG. 8.—Application of Density Requirements.

BASIS FOR 1600-LB. WORKING STRESS.

Considering that timber is to be used with a working stress of 1600 lb. per sq. in., the corresponding strength of the material under test should be preferably above 5700 lb. per sq. in., and in no case below 4700 lb. per sq. in. This relation is deduced as follows:

It is good practice in steel to make the working stress one-half the fiber stress at the elastic limit. On this basis the fiber stress at the elastic limit in wood corresponding to a working stress of 1600 lb. per sq. in. would be 3200 lb. per sq. in. The ratio of the fiber stress at the elastic limit to the modulus of rupture or breaking stress in wood is 9/16. This brings the breaking stress to correspond to a 1600-lb. working stress to $3200 \times 16/9 = 5700$ lb. per sq. in.

The so-called factor of safety in wood based on fiber stress at elastic limit should not in any case fall below $1\frac{2}{3}$, as it has been shown by tests that a dead load giving a fiber stress equal to the stress at the elastic limit has ultimately caused failure. In the same way that the breaking stress corresponding to a factor of 2 is 5700 lb. per sq. in., the breaking stress corresponding to a factor of $1\frac{2}{3}$ is approximately 4700 lb. per sq. in. On this basis any rule for selecting timber to be used with a working stress of 1600 lb. per sq. in. should give material with a breaking stress in the large majority of cases (75 per cent) above 5700 lb. per sq. in., with comparatively few pieces (25 per cent) between 5700 and 4700 lb. per sq. in., and with no pieces having a breaking stress less than 4700 lb. per sq. in.

RESULTS OF CLASSIFYING MATERIAL BY PROPOSED RULE.

Small Sticks.—In order to demonstrate the density part of the proposed rule and show graphically the relation between density, summer wood, rate of growth, contrast in color between summer wood and spring wood, and bending strength, small blocks of wood cut from the test pieces of longleaf, loblolly, pond, table-mountain, pitch, and Cuban pine were placed on a chart, their position being determined according to the density and strength of the test pieces. Fig. 9 shows the chart. The original is about 7 ft. square and the photograph is so much

reduced that the details are not clear. The method of making the chart is apparent however.

The results of applying the density requirement of the proposed rule to the small pieces in Fig. 9 are as follows: With longleaf pine, out of a total of 270 pieces, 185, or 68 per cent, fall

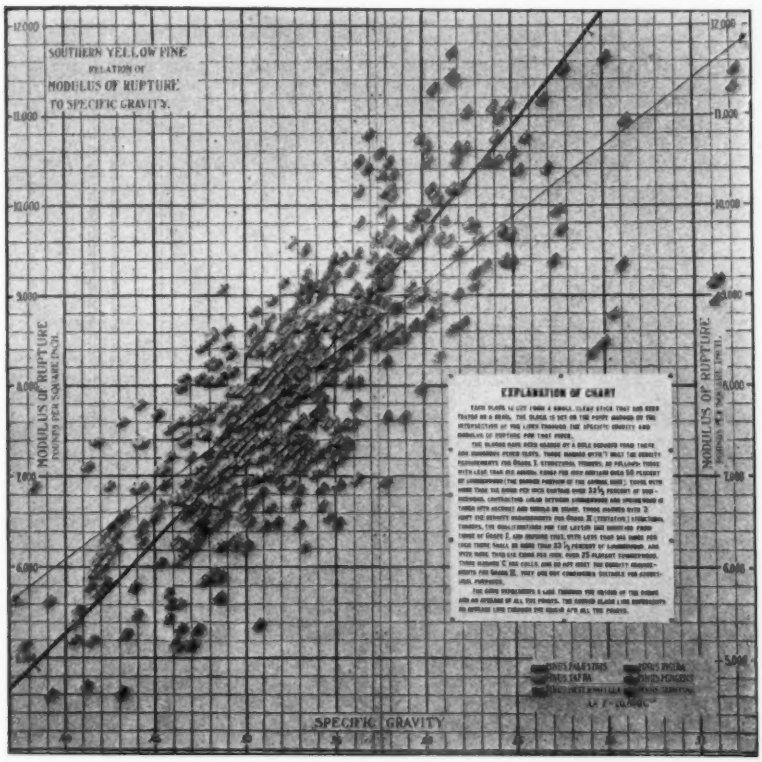


FIG. 9.—Relation between the Strength and Dry Weight of Southern Yellow Pine.

in Grade No. 1. With loblolly pine 32 pieces out of a total of 62 fall in Grade No. 1, or 51.5 per cent. It should be understood that the proportion of these pieces falling in Grade No. 1 does not necessarily represent the proportion of longleaf and loblolly-pine timber that would do so. Including all species, of the 450 pieces on the chart, 276, or 61 per cent fall in Grade No. 1.

Tests on large timbers containing the ordinary defects found in market material have shown that the bending strength of the full-size pieces averages three-fourths the strength of the small, clear pieces cut from them. Considering that a working stress of 1600 lb. per sq. in. corresponds to a breaking strength in structural material of 5700 lb. per sq. in., the same working stress would correspond to a breaking strength of $5700 \times 4/3 = 7600$ lb. per sq. in. in small, clear, straight-grained material similar to that used in making the chart. The lower limit in breaking strength for the small pieces on the chart would be $4700 \times 4/3 = 6300$ lb. per sq. in.

Eighty-five per cent of the material that falls in Grade No. 1 has a strength above 7600 lb. per sq. in., 14 per cent is between

TABLE I.—RESULTS OF APPLYING GRADING RULES TO 41 LONGLEAF YELLOW-PINE STRINGERS.

Range in Strength (Modulus of Rupture, lb. per sq. in.).	Number of Stringers Falling Between Range.						
	Yellow-Pine Manufacturers' Association Rules.		Forest-Service Rules (two grades).			Forest-Service Rules (one grade).	
	No. 1 Common.	Culls.	Grade No. 1.	Grade No. 2.	Culls.	Grade No. 1.	Remainder.
Below 4700.....	2	3	..	1	4	..	5
4700-5700.....	8	4	3	6	3	3	9
Above 5700.....	24	..	17	7	..	17	7

7600 and 6300 lb. per sq. in. and 1 per cent is below 6300 lb. per sq. in.

In the material classed as Grade No. 2, 55 pieces out of a total of 174 have a strength above 7600 lb. per sq. in. and properly belong in Grade No. 1.

Bridge Stringers.—During the summer of 1914 tests were made on 41 pieces of longleaf pines supplied by the former Yellow-Pine Manufacturers' Association. These were part of a shipment of 80 bridge stringers. Those tested were in a green condition. The remainder are still drying.

The material was graded by an inspector of the Yellow-Pine Manufacturers' Association using the association rules, and by a representative of the Forest Service using the Forest-Service rules. The results are shown in Table I.

APPENDIX III.

SOUTHERN YELLOW-PINE TIMBER AND DENSITY GRADING RULES.

By O. T. Swan.

The purpose of this paper is to point out briefly the conditions surrounding the manufacture and use of southern yellow-pine structural timbers which indicate the need of better selection and grading of the material. The development of the so-called "density rules" under which selective grading may be made is outlined, and there is also a summary of some of the studies of the Forest Service on the physical characteristics of southern pine. These studies give a better idea than has been possible heretofore, of the effect of various density rules upon the marketability of different species of yellow pine and of the material from different regions. The theoretical bearing of density rules and the extent to which their underlying principles can be made practical on a commercial basis is also discussed.

The Situation in the Trade.—The merchandising of yellow pine and the efficient use of this class of timber has suffered considerably through the lack of a definite separation of the material into quality classes, based on serviceability. In the case of structural timbers, serviceability depends primarily upon strength and resistance to decay. The selection method which has been chiefly employed up to this time, has been based upon the use of specific or trade names, such as "longleaf" or "shortleaf," in conjunction with differing association grade specifications, defining to a greater or less extent, allowable defects and the percentage of heartwood required. These grade requirements have not been standardized into a complete system which considers only the best method of securing serviceable material for the consumer, according to the several important classes of use.

The employment of such terms as "longleaf" and "shortleaf" in an effort to segregate quality classes is not only ineffec-

tive, in view of the fact that there is a very wide and overlapping margin of quality in the several southern pine species, but also leads to considerable confus on and loss of money in cases under dispute, since it is practically impossible to determine the species from an examination of the manufactured timber. The way is open for the substitution of material lacking in strength and particularly in durability in cases where it is presumed first-class material will be supplied. The early failure of such material has thrown discredit and loss upon the entire yellow-pine trade, and in some quarters it is even questioned whether it is possible practically to obtain first-class southern pine suitable for mill construction.

The great variation in strength which may be found in material graded under the present rules, has made it necessary for architects and engineers to base their strength calculations upon the poorer quality of material likely to be present in the grade. This has the effect of giving all southern pine the rating of its poorest material. Since this wood is one of the leading structural timbers, a low strength rating also permits more effective competition by substitute materials. Further, channels of trade become organized along such lines that the present available quality or grade of material permit present competition, and since there has been no adequate selection of structural grades within the meaning of this paper, there are many markets in which the stronger material is not available, the cheaper, less-serviceable material, of the same grade commercially, having driven the better timbers from the market. It is apparent therefore that those manufacturing and using yellow-pine structural timber will benefit to a marked degree if an inspection method can be put into general use which will separate the wood into quality classes, irrespective of species names, and which will guarantee certain high standards of strength and durability.

Previous Work.—While this situation has long been recognized by many, it is only recently that methods for meeting it have gained impetus. The timber strength tests of the Forest Service undoubtedly laid the ground work for this development, and Forest Service investigations have furnished the bulk of the data for the important advances made along this line.

One of the most important steps was taken by Committee D-7 on Standard Specifications for Timber of the American Society for Testing Materials, when in a report adopted in September, 1907, the Society went on record as follows:

Southern Yellow Pine.—Under this heading two classes of timber are used, (*a*) longleaf pine, (*b*) shortleaf pine.

It is understood that these two terms are descriptive of quality, rather than of botanical species. Thus, "shortleaf pine" would cover such species as are now known as North Carolina pine, loblolly pine, and shortleaf pine. "Longleaf pine" is descriptive of quality, and if Cuban, shortleaf, or loblolly pine is grown under such conditions that it produces a large percentage of hard summer wood, so as to be equivalent to the wood produced by the true longleaf, it would be covered by the term "longleaf pine."

In this definition an attempt was made to get away from the use of specific names, to point out that the quality of the wood should govern and to show that one of the governing factors was the relative percentage of hard summer wood. The publications of the Forest Service bearing on the strength of yellow pine have also laid emphasis on these points and shown more clearly the relation of the number of rings per inch and the percentage of summer wood to strength. The first definite practical rule, however, which came into wide use was the one prepared by the Forest Service in March, 1914, for the use of the Panama Canal in specifying southern yellow pine. It was evolved as the result of an inspection controversy over a large shipment of timber, in which longleaf pine was specified, and in which it was practically impossible to agree upon the percentage of the pieces of timber which were not of this species. This rule is as follows:

RULE ADOPTED BY THE PANAMA CANAL.

Yellow pine must show on the cross-section, between the third and fourth inch, measured radially from the heart center or pith, not less than six annual rings of growth, a greater number of which shall show at least one-third summer wood, the dark portion of the rings of growth. Wide-ringed material excluded by this rule will be acceptable, provided that in the greater number of the annual rings the dark ring is hard and in width equal to or greater than the adjacent light-colored ring. In all cases there must be sharp contrast in color between the spring and summer wood.

For sizes where the center can not be determined there must show on the cross-section an average of not less than six annual rings of growth, otherwise the same as the above paragraph.

In other respects to grade "Prime," Interstate Rules of 1905.

The use of this rule by the Panama Canal in its schedules calling for millions of feet of lumber monthly, immediately placed the matter effectively before the trade, arousing great interest and much favorable comment. About 10,000,000 ft. have been inspected under this rule.

At practically the same time the Georgia-Florida Sawmill Association, which had participated in some of the preliminary investigations leading to the formulation of the Panama-Canal rule, adopted a similar density rule, which is as follows:

RULE ADOPTED BY GEORGIA-FLORIDA SAW MILL ASSOCIATION.

Paragraph I.—For timbers and dimension, there must show on the cross-section between the third and fourth inch, measured radially from the heart center or pith, not less than six annual rings of growth, a greater number of which shall show at least one-third summer wood, which is the dark portion of the rings of growth. Wide ringed material excluded by this rule will be acceptable, provided that in the greater number of the annual rings the dark ring is hard and in width equal to or greater than the adjacent light-colored ring. In all cases there must be sharp contrast in color between the spring and the summer wood.

Paragraph II.—For sizes where the center cannot be determined the following will apply: There must show on the cross-section an average of not less than six annual rings of growth, with not less than one-third summer wood, and otherwise as provided for in Paragraph I.

The object of both the Panama-Canal rule and the Georgia-Florida rule, which was to be used in connection with the standard grades of the saw-mill association, was to get away from the use of specific names and to define the better quality of material in terms such that the inspection could be made satisfactorily no matter where the material was found.

The matter was then taken up by the Classification Committee of Structural Material of the Southern Yellow Pine Manufacturers' Association. This committee was anxious to define several structural grades of high quality and durability, in such manner that the quality of the material in the grade would be definitely determined and assured. The committee adopted not only a density requirement, but also a specification

relating to knots and other defects, based entirely on the timber strength tests of the Forest Service. The rule as adopted by the grades committee on May 4, 1914, is as follows:

GRADING RULE ADOPTED BY THE CLASSIFICATION COMMITTEE OF STRUCTURAL MATERIAL OF THE SOUTHERN YELLOW PINE MANUFACTURERS' ASSOCIATION.[1]

There are two grades provided for and called Select Structural and No. 1 Structural.

Select Structural Grade.—All timber shall be sound and sawed to standard sizes, *dense*, free from such defects as ring shake showing on the faces, injurious cross grain, unsound knots and decay.

Dense wood is defined as follows: Having the following characteristics showing on the cross-section and appearing in the third, fourth and fifth inches of a radial line from the pith or heart center: an average of eight annual growth rings per inch, provided that in the greater number of rings one-fourth

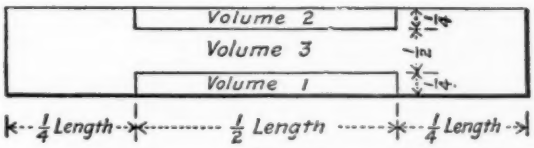


FIG. 1.

or more of the ring is summer wood; an average of six or seven rings, provided that in the greater number of the rings one-third or more of the ring is summer wood; or wider ringed material if in the greater number of rings, one-half or more of the ring is summer wood; and must show a sharp contrast in color between spring wood and summer wood.

Stringer forms must not have encased or large sound knots in volume 1 (Fig. 1); must not have large encased knots in volume 2 or unsound knots in volume 3; beam, post, sill and other forms may have sound knots or hard, firm encased knots, the aggregate diameter of which does not exceed the width of the face they are in, but no one knot shall exceed 4 in. in diameter; stringer forms shall show three-quarter heart at any point on the narrow faces, and post, beam and sill and other forms more nearly square shall show three-quarter heart on all faces at any point.

The measurement of knots shall be at right angles with the grain of the knot.

No. 1 Structural.—Shall include timber answering in all respects to select structural except that a greater proportion of sap of no restriction as to sap will be allowed, making timbers suitable for treatment and distinguishing them from No. 1 common timber.

[1] Adopted by the committee May 4, 1914, and approved by the Board of Directors and recommended by them for adoption by the semi-annual convention in the fall of 1915.

In order to complete the basic data required to formulate rules of this character and to determine more closely the effect upon the southern timber regions, the Forest Service made definite plans in 1914 to make further timber strength tests, and through field studies at representative points in the South, to place on record the variations in quality of the several species as indicated by exact measurements of the number of rings per inch, percentage of summer wood, proportion of heart-wood, etc. The discussion which follows outlines these results and their correlation with the timber test data. The resulting rule based on this more complete information is as follows:

RULE PROPOSED BY THE FOREST SERVICE.

Requirements for Density and Rate of Growth.[1]

1. Shall contain only sound wood.

2. On a radial line from the pith, the inspection area shall show on the cross-section an average of six or more annual rings of growth to the inch with one-third summer wood, or one-half summer wood if the average number of annual rings of growth is less than six:

1. *Pith present or accurately located.*—

(*a*) Radial line of 5 in. present:

1. Apply inspection over third, fourth and fifth inches.

(*b*) Radial line of 5 in. not present:

1. Apply inspection to the second inch on 2 by 3, 2 by 4, 2 by 6, 3 by 3, 3 by 4, 4 by 4 in., or any other dimension material that has less than 16 sq. in. on the cross-section.

2. In larger material apply inspection to the three inches farthest from the pith.

2. *Pith not present or can not be accurately located.*—

(*a*) Material over 3 in. thick apply inspection to three inches nearest the pith.

(*b*) Dimension material 3 in. or less in thickness apply inspection to second inch on the piece nearest the pith.

3. The radial line chosen shall show a representative number of annual rings of growth and per cent of summer wood. In case of disagreement between purchaser and seller the figures used shall be obtained by averaging the number of annual rings and percentage of summer wood on the two chosen inspection areas.

4. The summer wood must be dark and show a sharp contrast in color to the spring wood.

5. It is sufficient if either end passes the inspection.

[1] Restrictions on knots in beams which have also been determined are not shown here.

Present Production of Yellow Pine Structural Material.—A map showing the approximate location of yellow pine mills cutting more than 5,000,000 ft. annually has been prepared by the Forest Service.[1] This map shows the center of production in each state and the center of production for the states as a group of mills cutting more than 1,000,000 feet annually. It shows further the location of the representative points which were chosen for study in the woods, at sawmills, and in the markets.

TABLE I.—YELLOW-PINE PRODUCTION.

State.	Estimated Production of Different Species						Total, M ft.	Structural Timber Produced, percentage of output.[2]
	Longleaf and Cuban.		Shortleaf.		Loblolly.			
	M ft.	Per cent.	M ft.	Per cent.	M ft.	Per cent.		
North Carolina	82 937	5	414 686	25	1 161 121	70	1 658 744	11
South Carolina	37 560	5	375 600	50	338 040	45	751 198	16
Georgia	319 748	40	199 842	25	279 779	35	799 370	40
Florida	768 588	80	.....	..	192 147	20	960 735	50
Alabama	911 250	75	121 500	10	182 250	15	1 214 994	33
Mississippi	1 420 493	70	304 391	15	304 391	15	2 029 276	50
Louisiana	2 196 474	75	585 726	20	146 431	5	2 928 632	45
Texas	916 951	50	183 390	10	733 561	40	1 833 902	40
Arkansas	.....	..	510 056	45	623 402	55	1 133 458	..
Total	6 654 000		2 893 200		4 752 800		13 310 316	

[2] From reports of mills producing 5,000,000 board feet and over per year.

Table I shows the estimated amount of lumber cut from the several species in each state. These rough estimates will serve for purposes of discussion, and are presented in order that the effect of proposed density rules on different species and different producing regions may be better understood. Table I also shows the proportion of the output of the mills in each state which is in the form of structural material. The latter estimates are from reports of a large number of mills producing 5,000,000 board feet and over per year, and are very representative.

Number of Rings per Inch and Percentage of Summer Wood.—Table II summarizes the results of the field work in the principal

[1] This map is not reproduced here.—ED.

TABLE II.—SUMMARY OF RESULTS OF FIELD WORK.

Species.	Average Diameter of Tree at Breast Height, in.	Average Length Merchantable, ft.	Average Sap Wood on Radius, in.			Average Heart Wood on Radius, in.			Butt.																						
									Number of Rings per Inch and Percentage of Summer Wood at Designated Inches on the Cross Section, measured from the Pith.																						
			Butt.	Middle.	Top.	Butt.	Middle.	Top.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Longleaf Pine	17.3	45.7	2.7	2.3	2.3	6.0	4.7	2.9	13.6	13.0	13.6	13.9	14.2	15.7	16.5	17.6	19.9	22.0	23.4	24.9	24.5	24.4	22.5	21.7	30.5	26.0	....	....	....
	455	*394*	*452*	*90*	*382*	*458*	*90*	*384*	*448*	*454*	*454*	*454*	*453*	*445*	*375½*	*301*	*222½*	*160¾*	*100*	*64*	*32*	*18*	*7*	*4*	*2*	*1*	....	....	....
	.....	....	....	....	....	....	....	....	....	....	**47**	**48**	**50**	....	**49**	....	**47**	....	**46**	....	**43**	....	**45**	....	**45**	....	....	....	....
	.....	....	....	....	....	....	....	....	....	....	....	....	*454*	....	*373*	....	*224*	....	....	....	*35*	....	....	....	*1*	....	....	....	....
Shortleaf Pine	16.9	48.6	4.2	3.1	3.3	4.5	4.0	1.9	12.9	11.6	11.4	11.0	10.4	10.5	11.2	12.0	12.5	13.8	15.7	15.9	17.1	21.3	23.1	22.0	21.1	30.0	22.0	26.0	....
	427	*398*	*427*	*125*	*381*	*426*	*125*	*361*	*414*	*421*	*426*	*426*	*428*	*408½*	*354½*	*277¼*	*206*	*148¾*	*97*	*50*	*23*	*13*	*9¼*	*7*	*4½*	*2*	*1½*	*1*	....
	.....	....	....	....	....	....	....	....	....	....	**36**	**37**	**37**	....	**37**	....	**36**	....	**35**	....	**38**	....	**41**	....	**45**	....	**40**	....	....
	.....	....	....	....	....	....	....	....	....	....	....	....	....	....	*365*	....	*214*	....	*101*	....	*22*	....	*10*	....	*5*	....	*2*	....	....
Loblolly Pine	19.2	49.1	5.1	4.3	3.7	4.6	3.3	2.3	9.3	7.9	7.3	7.2	7.2	7.4	8.8	8.5	9.5	9.9	10.7	11.7	13.3	16.1	16.3	15.4	16.2	29.2	35.5	38.0	....
	575	*530*	*674*	*186*	*513*	*575*	*186*	*492*	*567*	*573*	*575*	*575*	*575*	*565*	*475*	*465*	*367*	*280½*	*213*	*151¼*	*97*	*47½*	*26*	*10½*	*8*	*3½*	*2*	*1*	....
	.....	....	....	....	....	....	....	....	....	....	**36**	**38**	**40**	....	**41**	....	**42**	....	**41**	....	**39**	....	**44**	....	**43**	....	**45**	....	....
	.....	....	....	....	....	....	....	....	....	....	....	....	*574*	....	*529*	....	*373*	....	*218*	....	*100*	....	....	....	....	....	....	....	....
Cuban Pine	19.4	42.1	2.6	....	2.3	7.5	....	4.0	9.4	8.5	8.3	8.2	8.2	9.7	11.5	12.8	14.0	14.8	15.4	17.3	16.0	18.8	9.5	11.5	6.0	5.0	7.0	10.0	20.0
	134	*133*	*127*	....	*133*	*134*	....	*133*	*131*	*133*	*134*	*134*	*134*	*134*	*128*	*115*	*98*	*66¾*	*50*	*40*	*19*	*12*	*4*	*2*	*1*	*1*	*1*	*1*	*1*
	.....	....	....	....	....	....	....	....	....	....	**52**	**57**	**59**	....	**58**	....	**58**	....	**58**	....	**57**	....	**50**	....	**40**	....	**50**	....	**60**
	.....	....	....	....	....	....	....	....	....	....	....	....	....	....	*127*	....	....	....	*49*	....	*18*	....	*3*	....	....	....	....	....	....
Pond Pine	20.1	44.5	5.9	3.9	4.1	4.1	3.1	2.4	5.1	4.3	4.2	4.6	5.3	6.0	6.3	7.2	9.0	8.3	8.2	9.8	11.0	11.0	9.0	10.0	....	....	....	....	....
	50	*50*	*50*	*4*	*50*	*50*	*4*	*50*	*50*	*50*	*50*	*50*	*50*	*50*	*28*	*26*	*25*	*18*	*14*	*5*	*3*	*1*	*1*	*1*	....	....	....	....	....
	.....	....	....	....	....	....	....	....	....	....	**43**	**46**	**48**	....	**53**	....	**52**	....	**52**	....	**45**	....	**50**	....	....	....	....	....	....
	.....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	*24*	....	....	....	*2*	....	....	....	....	....	....	....	....

EXPLANATORY NOTE.

The first line of figures under the consecutive inch-mark column headings records the number of growth rings found in that inch. The bold-face figures record the percentage of summer wood. The italic figures indicate the number of cases averaged.

TABLE II.—*Continued.*

Species.	15 to 20 Ft. — Number of Rings per Inch and Percentage of Summer Wood at Designated Inches on the Cross Section, measured from the Pith.												21 to 30 Ft. — Number of Rings per Inch and Percentage of Summer Wood at Designated Inches on the Cross Section, measured from the Pith.													
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Longleaf Pine	8.2	9.8	12.0	16.2	23.3	27.0	26.6	29.2	47.0	....	....	....	9.6	13.4	15.3	17.9	20.6	20.6	27.0	26.0	30.5	30.0	30.0	....	....	....
	13	*15*	*13*	*13*	*11*	*6*	*3*	*2½*	*1*	....	....	....	*47*	*49*	*49*	*45*	*28*	*15½*	*11*	*4½*	*4*	*1*	*1*	....	....	....
	....	....	**36**	**38**	**38**	....	**45**	....	**50**	....	....	....	....	....	**33**	**34**	**37**	....	**38**	....	**42**	....	**35**	....	....	....
	....	....	....	....	*12*	....	....	....	....	....	....	....	....	....	....	*46*	*31*	....	*12*	....	....	....	....	....	....	....
Shortleaf Pine	7.1	8.3	10.8	10.9	14.0	15.5	18.0	28.0	24.0	22.0	30.0	....	8.1	9.1	10.1	9.7	12.7	16.3	16.6	19.0	21.0	....	....	....	....	....
	16	*16*	*16*	*14*	*11½*	*10*	*7*	*2*	*1*	*1*	*1*	....	*28*	*28*	*28*	*26*	*19½*	*15*	*10*	*6*	*1*	....	....	....	....	....
	....	....	**31**	**35**	**36**	....	**37**	....	**40**	....	**35**	....	....	....	**27**	**30**	**32**	....	**33**	....	**30**	....	....	....	....	....
	....	....	....	....	*14*	....	....	....	....	....	....	....	....	....	....	*27*	*20*	....	....	....	....	....	....	....	....	....
Loblolly Pine	7.0	7.4	8.5	9.0	9.0	8.7	9.1	10.4	12.0	15.3	17.0	10.0	6.8	7.1	7.9	9.0	10.0	11.6	12.3	12.4	15.2	16.5	20.6	20.0	7.0	10.0
	34	*34*	*34*	*33½*	*27*	*21½*	*15*	*10*	*6½*	*4½*	*2*	*½*	*97*	*98*	*98*	*98*	*87*	*73*	*50*	*33*	*24*	*15½*	*6½*	*2*	*1*	*1*
	....	....	**31**	**33.5**	**35**	....	**35**	....	**35**	....	**35**	....	....	....	**30**	**31**	**33**	....	**34**	....	**35**	....	**33.5**	....	**40**	....
	....	....	....	*34*	....	....	*16*	....	*7*	....	....	....	....	....	....	....	*88*	....	*55*	....	....	....	*7*	....	....	....
Cuban Pine	....	....	....	....	....	....	....	....	....	....	....	....	5.3	7.0	9.3	10.0	16.1	21.3	22.0	20.0	12.0	....	....	....	....	....
	....	....	....	....	....	....	....	....	....	....	....	....	*6*	*6*	*6*	*6*	*6*	*6*	*3*	*2*	*1*	....	....	....	....	....
	....	....	....	....	....	....	....	....	....	....	....	....	....	....	**28**	**30**	**34**	....	**28**	....	**60**	....	....	....	....	....
Pond Pine	3.5	6.5	6.5	9.5	16.0	....	....	....	....	....	....	....	2.8	3.5	4.3	6.1	7.6	8.7	7.8	9.3	10.5	....	....	....	....	....
	2	*2*	*2*	*2*	*1½*	....	....	....	....	....	....	....	*6*	*6*	*6*	*6*	*6*	*5½*	*5*	*4½*	*2*	....	....	....	....	....
	....	....	**30**	**30**	**37**	....	....	....	....	....	....	....	....	....	**35**	**37**	**38**	....	**43**	....	**37**	....	....	....	....	....
	....	....	....	....	*2*	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

EXPLANATORY NOTE.

The first line of figures under the consecutive inch-mark column headings records the number of growth rings found in that inch. The bold-face figures record the percentage of summer wood. The italic figures indicate the number of cases averaged.

states producing structural yellow pine, in so far as the number of rings per inch and the percentage of summer wood is concerned. The numerals 1, 2, 3, 4, etc., indicate the inch on the cross-section, measured from the pith, to which the figures below apply. The first line of figures under the consecutive inch mark column headings records the number of growth rings found in that inch; under this is a figure showing how many cases were averaged to get the average number of rings. Under this, for the third, fourth and fifth inches and every other inch the percentage of summer wood is recorded, together with the number of cases averaged. These measurements are shown for the butt section and other sections taken at different heights in the tree, and show that the number of rings per inch increases with the height at which the section is taken and that the percentage of summer wood decreases. They also show that on a given cross-section the number of rings per inch increases from the center outward, and indicate the average relation between the number of rings on the inspection inch and the average for the piece.

From Table II deductions may also be made as to the relation between the percentage of summer wood on any given inspection inch and the average percentage of summer wood for the cross-section. Since it is much more uniform, the percentage of summer wood does not vary across the surface of the section in the same manner that the number of rings per inch changes. Table II is discussed further under the heading "Inspection Area," immediately following.

Inspection Area.—It is the purpose of the inspection to determine the quality of the piece by an examination of an end of the timber, the points considered being the number of rings per inch, the proportion of summer wood, and the sharpness of the contrast between summer wood and spring wood. Theoretically the entire cross-section should be carefully measured from pith to circumference over an average radius. Since this is impractical in lumber inspection work, the first proposal has been to select a certain part of this radius which is presumably representative. Two inspection areas have been suggested, the first consisting of the fourth inch from the heart center, and

the second consisting of the third, fourth and fifth inches, which it is presumed is slightly more representative.

The first questions which were determined from the data were (1) the extent to which these inspection areas represented the rest of the radial line, and (2) which inspection area, namely, the fourth inch, or the third, fourth and fifth inches, was the more representative.

Table II shows that the average number of rings per inch for the cross-section will be greater than that at the inspection point. It shows that the percentage of summer wood will be approximately the same, although there are variations in a certain percentage of cases either above or below the average. In 13.3 per cent of cases the summer-wood assignment of the fourth inch threw the grading of the piece into the next higher summer-wood class. In 7.3 per cent of cases the summer-wood grading of the third, fourth and fifth inches threw the summer wood grading into a higher class. There is, therefore, a small error in the representative character of the inspection point so far as summer wood is concerned.

It is also shown in Table II that on the average the determination of the summer wood as indicated by either the fourth inch or the third, fourth and fifth inches is the same, but that the fourth inch alone is less accurate in a percentage of individual cases.

It should be remembered that the summer-wood determination as given by the inspection area should be representative not only of the average for the cross-section but of an average for the full length of the piece. There is a still greater error in its complete representative character than exists between the two inspection areas themselves.

Inspection End.—While the number of rings per inch increases the higher up the tree the section is taken, the percentage of summer wood decreases. Accordingly, there is considerable difference in these characters on the opposite ends of the piece. The following cases show the percentage of difference in amount of summer wood between the two ends of the piece. The percentage indicates the extent to which the proportion of summer wood at the small end is less than that at the large end.

						Difference.	
25	pieces	36	ft.	long	at Jacksonville	2.2	per cent
3	"	12	"	"	"	25.0	"
25	"	40	"	"	" Pensacola	17.5	"
50	"	36	"	"	" Port Arthur	21.5	"
35	"	24	"	"	" St. Marys	25.0	"
25	"	16	"	"	" Rodman	20.0	"
30	"	22	"	"	" Bude	10.5	"
50	"	16	"	"	" Lake Charles	14.5	"
5	"	30	"	"	" " "	5.0	"
25	"	30	"	"	" " "	17.0	"
15	"	16	"	"	" Ludington	29.0	"
10	"	34	"	"	" Bogalusa	31.0	"

The figures show clearly that the summer wood as determined by one end, even though the piece may be as short as 12 to 16 ft., may be in error 10 per cent or even more so far as representing the average for the piece.

This indicates (1) that great exactness in specifying the percentage of summer wood at the inspection point is not essential; (2) that if the relation between summer wood and strength were very close, it would be essential to require either (*a*) that the inspection be made at the poorer end, or (*b*) that the summerwood requirement applicable to either end be raised approximately 10 per cent or more.

It is an argument in favor of using only the fourth inch instead of the third, fourth and fifth inches, since the error is smaller between the two inspection areas than between the two ends of the piece.

Factors of Error in Making Commercial Inspection.—The apparent errors in determining average summer wood for the entire tree as based upon definite inspection points have been discussed. In order to determine how close the requirements on summer wood should be drawn, it is important to consider how closely they can be determined in average inspection at the mill. Commercial practice will not justify measurement by instruments but will require a quick measure by the eye. If the inspection point covers one inch only, a better judgment can be made than if three inches must be considered. Even though but one inch is considered there is apt to be a wide error in judgment, not only between different men, but between

any inspector and the actual measurement of the piece. Actual trials made by several men each inspecting 20 sections of pine showed errors of judgment in estimating the number of rings and the percentage of summer wood as follows: the number of rings was underestimated from 15 to 38 per cent with an average underestimate of 29 per cent; the percentage of summer wood was underestimated from 2.6 to 14 per cent, with an average underestimate of $4\frac{1}{2}$ per cent of the actual percentage of summer wood over the three inspection inches.

It should be pointed out that this average of 80 examinations is merely indicative, and that an inspector after becoming familiar with the method may or may not make a much better showing. Nevertheless, it serves to point out a very practical difficulty.

Effect of Density Rules on Species.—Table III shows the percentage of each log section of the tree from butt to top which will be passed or rejected by the rule given in the first column at the left. The rule given as Rule No. 1 is the density requirement of the proposed Forest-Service rule. In each case the result of inspection at the fourth inch alone is shown in comparison with the inspection at the third, fourth and fifth inches.

Table III shows that butt logs most readily pass the rule, and that longleaf and Cuban pine will pass the rule in a high percentage of cases, the top logs of shortleaf and loblolly being rejected in a large per cent of cases. To determine the effect of the rule on different regions, the results shown in Table III should be compared with the distribution statistics given in Table I.

Application of the Rule to Material of Different Dimensions.—At first density rules were applied to the entire cross-section. A tremendous advance was made in the Panama-Canal rule when the inspection area was confined to a definite relatively small surface.

The first application of the rule was in connection with large-dimension pieces, but when an attempt was made to apply a similar rule to smaller sizes with the pith present or not present, it was found that it was not specific enough to prevent disagreements as to methods, or accurate enough to give a fair average idea of the quality of material in some cases.

TABLE III.—YELLOW-PINE DENSITY RULES APPLIED TO TIMBER DATA.

(Measurements taken on Cross-Section on a Radial Line from the Center or Pith.)

RULE No. 1.

Rule. Amount of Summer Wood.	Rule. Number of Annual Rings to equal the Summer Wood.	Inch Measured.	Species.	Height from Ground, ft.																			
				Butt.		15–20.		21–30.		31–40.		41–50.		51–60.		61–70.		71–80.		81–90.		91–100.	
				Measurements Taken.	Rejected, per cent.	Measurements Taken.	Rejected, per cent.	Measurements Taken.	Rejected, per cent.	Measurements Taken.	Rejected, per cent.	Measurements Taken.	Rejected, per cent.	Measurements Taken.	Rejected, per cent.	Measurements Taken.	Rejected, per cent.	Measurements Taken.	Rejected, per cent.	Measurements Taken.	Rejected, per cent.	Measurements Taken.	Rejected, per cent.
½	Less than 6	4th	Longleaf Pine	454	3.7	13	15	46	33	176	23	92	22	63	35	34	26	20	35	2	50	..	..
			Shortleaf Pine	426	33	16	50	27	63	220	64	68	84	74	87	55	89	29	93	2	100	..	..
			Loblolly Pine	575	44	34	47	98	58	227	69	118	76	86	76	80	70	43	77	11	73	2	50
			Cuban Pine	134	6	..	..	6	83	64	25	37	11	10	33	4	0	4	25	..	..	..	..
			Pond Pine	30	43	2	100	6	83	13	62	4	75	1	0	4	100	4	75	..	..	..	..
			Total	1619		65		183		700		319		234		177		100		15		2	
or																							
½	6 or more	Average of 3rd, 4th and 5th	Longleaf Pine	454	3.5	13	15	46	39	175	23	91	30	62	34	34	21	20	35	2	50	..	..
			Shortleaf Pine	425	31	16	50	27	67	220	68	67	79	74	90	53	89	29	93	2	50	..	..
			Loblolly	576	45	32	44	98	59	227	64	117	79	86	75	80	64	42	81	11	82	2	50
			Cuban Pine	133	7	..	..	6	67	64	16	37	16	10	20	4	0	4	25	..	..	..	..
			Pond Pine	30	53	2	50	6	83	13	61	4	100	1	0	4	100	4	50	..	..	..	..
			Total	1618		63		183		699		316		233		175		99		15		2	

RULE No. 2.

½	Less than 7	4th	Longleaf Pine	454	9	13	15	46	33	176	23	92	24	63	35	34	26	20	35	2	50	..	..
			Shortleaf Pine	426	38	16	56	27	63	220	64	68	84	74	87	55	89	29	93	2	100	..	..
			Loblolly Pine	575	55	34	62	98	60	227	69	118	79	86	78	80	75	43	79	11	73	2	50
			Cuban Pine	134	8	..	..	6	83	64	28	37	14	10	40	4	0	4	25	..	..	..	..
			Pond Pine	30	47	2	100	6	83	13	62	4	100	1	0	4	100	4	75	..	..	..	..
			Total	1619		65		183		700		319		234		177		100		15		2	
or																							
½	7 or more	Average of 3rd, 4th and 5th	Longlead Pine	454	6.5	13	15	46	39	175	23	91	31	62	34	34	21	20	35	2	50	..	..
			Shortleaf Pine	425	36	16	50	27	67	220	68	67	79	74	90	53	89	29	93	2	50	..	..
			Loblolly Pine	576	58	32	62	98	63	227	67	117	82	86	79	80	68	42	86	11	82	2	50
			Cuban Pine	133	11	..	..	6	67	64	20	37	16	10	33	4	0	4	25	..	..	..	..
			Pond Pine	30	57	2	50	6	83	13	61	4	100	1	0	4	100	4	50	..	..	..	..
			Total	1618		63		183		699		316		233		175		99		15		2	

TABLE III.—*Continued.*

RULE No. 3.

Rule. Amount of Summer Wood.	Rule. Number of Annual Rings to equal the Summer Wood.	Inch Measured.	Species.	Height from Ground, ft. Butt. Measurements Taken.	Butt. Rejected, per cent.	15–20. Measurements Taken.	15–20. Rejected, per cent.	21–30. Measurements Taken.	21–30. Rejected, per cent.	31–40. Measurements Taken.	31–40. Rejected, per cent.	41–50. Measurements Taken.	41–50. Rejected, per cent.	51–60. Measurements Taken.	51–60. Rejected, per cent.	61–70. Measurements Taken.	61–70. Rejected, per cent.	71–80. Measurements Taken.	71–80. Rejected, per cent.	81–90. Measurements Taken.	81–90. Rejected, per cent.	91–100. Measurements Taken.	91–100. Rejected, per cent.
½	Less than 8	4th	Longleaf Pine	454	11.5	13	15	46	37	176	25	92	25	63	36	34	26	20	35	2	50	..	..
			Shortleaf Pine	426	44	16	69	27	67	220	64	68	84	74	87	55	89	29	96	2	100	..	..
			Loblolly Pine	575	62	34	82	98	66	227	74	118	81	86	83	80	76	43	84	11	73	2	50
			Cuban Pine	134	12	..	..	6	83	64	36	37	16	10	40	4	0	4	25	..	..	..	..
			Pond Pine	30	50	2	100	6	83	13	70	4	100	1	0	4	100	4	75	..	..	..	..
			Total	1619		65		183		700		319		234		177		100		15		2	
or																							
½	8 or more	Average of 3rd, 4th and 5th	Longleaf Pine	454	11	13	15	46	41	175	27	91	32	62	34	34	21	20	35	2	50	..	..
			Shortleaf Pine	425	41	16	63	27	67	220	69	67	79	74	90	53	89	29	96	2	50	..	..
			Loblolly Pine	576	67	32	72	98	70	227	76	117	86	86	85	80	72	42	86	11	82	2	50
			Cuban Pine	133	13	..	..	6	67	64	28	37	27	10	33	4	0	4	25	..	..	..	..
			Pond Pine	30	67	2	50	6	83	13	77	4	100	1	0	4	100	4	50	..	..	..	..
			Total	1618		63		183		699		316		233		175		99		15		2	

RULE No. 4

½	Less than 6	4th	Longleaf Pine	454	2.6	13	0	46	2	176	2	92	1	63	3	34	3	20	10	2	0	..	..
			Shortleaf Pine	426	15	16	31	27	33	220	18	68	32	74	28	55	31	29	17	2	0	..	..
			Loblolly Pine	575	37	34	24	98	38	227	39	118	45	86	47	80	34	43	33	11	36	2	50
			Cuban Pine	134	6	..	..	6	33	64	6	37	3	10	20	4	0	4	0	..	..	..	..
			Pond Pine	30	43	2	0	6	83	13	54	4	75	1	0	4	0	4	50	..	..	..	..
			Total	1619		65		183		700		319		234		177		100		15		2	
or																							
¼	6 or 7	Average of 3rd, 4th and 5th	Longleaf Pine	454	3.1	13	0	46	2	175	1	91	1	62	2	34	3	20	5	2	0	..	..
			Shortleaf Pine	425	16	16	31	27	41	220	22	67	39	74	30	53	26	29	21	2	0	..	..
or			Loblolly Pine	576	36	32	19	98	39	227	41	117	48	86	44	80	24	42	43	11	27	2	50
¼	8 or more		Cuban Pine	133	7	..	..	6	17	64	5	37	8	10	0	4	0	4	0	..	..	..	..
			Pond Pine	30	53	2	0	6	83	13	54	4	100	1	0	4	0	4	25	..	..	..	..
			Total	1618		63		183		699		316		233		175		99		15		2	

TABLE III.—*Continued.*

RULE No. 5.

Rule. Amount of Summer Wood.	Rule. Number of Annual Rings to equal the Summer Wood.	Inch Measured.	Species.	Height from Ground, ft. Butt. Measurements Taken.	Butt. Rejected, per cent.	15–20. Measurements Taken.	15–20. Rejected, per cent.	21–30. Measurements Taken.	21–30. Rejected, per cent.	31–40. Measurements Taken.	31–40. Rejected, per cent.	41–50. Measurements Taken.	41–50. Rejected, per cent.	51–60. Measurements Taken.	51–60. Rejected, per cent.	61–70. Measurements Taken.	61–70. Rejected, per cent.	71–80. Measurements Taken.	71–80. Rejected, per cent.	81–90. Measurements Taken.	81–90. Rejected, per cent.	91–100. Measurements Taken.	91–100. Rejected, per cent.
½	Less than 7	4th	Longleaf Pine	454	8	13	0	46	4	176	3	92	7	63	5	34	3	20	10	2	0	..	..
			Shortleaf Pine	426	26	16	37	27	44	220	34	68	46	74	46	55	40	29	28	2	0	..	..
			Loblolly Pine	575	50	34	50	98	51	227	55	118	59	86	60	80	48	43	51	11	63	2	50
			Cuban Pine	134	8	..	..	6	50	64	12	37	8	10	30	4	0	4	0	..	..	..	..
	or		Pond Pine	30	47	2	50	6	83	13	54	4	100	1	0	4	50	4	50	..	..	..	..
⅓	7 to 9		Total	1619		65		183		700		319		234		177		100		15		2	
	or	Average of 3rd, 4th and 5th	Longleaf Pine	454	6	13	8	46	2	175	2	91	10	62	5	34	3	20	5	2	0	..	..
			Shortleaf Pine	425	26	16	31	27	48	220	37	67	48	74	49	53	38	29	31	2	0	..	..
			Loblolly Pine	576	53	32	56	98	53	227	55	117	65	86	61	80	44	42	57	11	64	2	50
			Cuban Pine	133	11	..	..	6	33	64	13	37	11	10	10	4	0	4	0	..	..	..	..
¼	10 or more		Pond Pine	30	57	2	0	6	83	13	54	4	100	1	0	4	25	4	50	..	..	..	..
			Total	1618		63		183		699		316		233		175		99		15		2	

RULE No. 6.

½	Less than 8	4th	Longleaf Pine	454	11	13	0	46	9	176	5	92	8	63	6	34	3	20	10	2	0	..	..
			Shortleaf Pine	426	33	16	50	27	48	220	35	68	46	74	46	55	40	29	31	2	0	..	..
			Loblolly Pine	575	57	34	71	98	57	227	60	118	62	86	65	80	49	43	56	11	63	2	50
			Cuban Pine	134	12	..	..	6	50	64	20	37	11	10	30	4	0	4	0	..	..	..	..
	or		Pond Pine	30	50	2	50	6	83	13	62	14	100	1	0	4	50	4	50	..	..	..	..
⅓	8 or 9		Total	1619		65		183		700		319		234		177		100		15		2	
	or	Average of 3rd, 4th and 5th	Longleaf Pine	454	11	13	8	46	4	175	5	91	11	62	5	34	3	20	5	2	0	..	..
			Shortleaf Pine	425	31	16	44	27	48	220	38	67	48	74	49	53	38	29	35	2	0	..	..
			Loblolly Pine	576	62	32	66	98	60	227	64	117	69	86	66	80	49	42	57	11	64	2	50
			Cuban Pine	133	13	..	..	6	33	64	20	37	22	10	10	4	0	4	0	..	..	..	..
¼	10 or more		Pond Pine	30	67	2	0	6	83	13	69	4	100	1	0	4	25	4	50	..	..	..	..
			Total	1618		63		183		699		316		233		175		99		15		2	

The proposed Forest-Service rule is sufficiently detailed to take care of all possible cases of this character, and is so designed and the inspection area so located as to be a fair criterion of the quality of the piece.

In order to show how the inspection is applied to different dimensions the several parts of the rule are presented separately, followed by illustrations of acceptable and rejected material shown in Figs. 7 and 8 (Appendix II).[1] In studying these pictures it will be illuminating to compare the classification of the same piece as it would be made under each of the earlier density rules. The advantage of the proposed rule is obvious.

[1] See pp. 380-381.—ED.

DISCUSSION.

Mr. Carpenter.

MR. A. W. CARPENTER.—I think that nearly, if not quite everybody will agree that this proposed change in classification is a very sensible one and very desirable; but there are some things in the wording of the definitions and specifications that I think are open to some suggestion or criticism. For instance, in the proposed revisions of the Standard Classification of Structural Timber, Section 1 (*a*), defining dense southern yellow pine, it is not entirely clear to me just what is meant. It requires that the timber "shall show on either end an average of at least six annual rings per inch and at least one-third summer wood," and then there is another provision, reading "or else the greater number of the rings shall show at least one-third summer wood;" then it states, "all as measured over the third, fourth and fifth inches on a radial line from the pith." Now I take it that the qualification "as measured," refers to the "average of at least six annual rings," and to "at least one-third summer wood" as well as to the second provision. However, I am not altogether sure about that.

Mr. von Schrenk.

MR. HERMANN VON SCHRENK (*Chairman of Committee D-7*). —Mr. Carpenter's understanding of these clauses is correct.

Mr. Carpenter.

MR. CARPENTER.—It seems to me there is some inconsistency in stating that the timber shall show an average of at least one-third summer wood or else that the greater number of the rings shall show at least one-third summer wood. If the greater number of the rings should show only one-third summer wood, the average would be less than one-third.

Mr. von Schrenk.

MR. VON SCHRENK.—I must say that for a good many months, the best of us have been working to make this definition as clear as possible. It was first formulated by the Forest Service after several years of work, and the specifications were submitted at several meetings of the committee as well as to all members by correspondence, and also to the manufacturers, and after a thorough canvass of the situation, we came to the conclusion that this expressed the subject as clearly as possible.

If any definite suggestion for improvement can be made I am sure the committee would gladly entertain it, but we should regret having this whole matter held up merely for slight changes in terminology. **Mr. von Schrenk.**

MR. CARPENTER.—I would not propose any change at this time, but would offer what I have said as a suggestion to the committee in the consideration of future revisions. **Mr. Carpenter.**

MR. VON SCHRENK.—The only revision from the present standard specifications contained in the proposed revised Standard Specifications for Yellow-Pine Bridge and Trestle Timbers,[1] is a change in nomenclature of the grade. We did not change the wording of the present specifications, believing that any slight changes in wording might be made later. **Mr. von Schrenk.**

MR. CARPENTER.—I should like to suggest a few other points to the committee for possible improvements in the specifications. I never liked that first clause in the Standard Specifications for Yellow-Pine Bridge and Trestle Timbers. It strikes me that it is rather indefinite. In the first place, it has a requirement as to how the timber shall be cut. I very much doubt if any determination from timber already cut can be made as to what kind of trees it is cut from, except that the timber itself is sound. The next point is the requirement that the timber shall be "close-grained." Before we had a further requirement for closeness of grain, that might have had some bearing, but now the closeness of grain is very definitely specified, except in the specific requirement for sound yellow pine, which does not include the closeness of grain; and I do not know whether or not close-grained material is required for that grade. The next requirement is: "free from such defects as *injurious* ring shakes and crooked grain." Now the material should, of course, be free from any injurious defects, but it has always seemed to me very unsatisfactory to say that it shall be free from "injurious" ring shakes. Is there a ring shake that is not injurious? Or, is there a ring shake that is beneficial? This ought to be more closely defined. Again, does the word "injurious" qualify "crooked grain?" When one has to interpret specifications for inspectors, one may get into a lot of trouble over such points. **Mr. Carpenter.**

There is one other point; that is, in regard to the way the

[1] These specifications appear in the 1915 Year-Book, pp. 431–434.—ED.

Mr. Carpenter. words "dense" and "sound" are written in the specifications. The word "sound," especially, is a common general term. To speak of "sound, yellow pine" without italicizing "sound" or making it appear that "sound" is a grade, may lead to misinterpretation. It would seem that the words "sound" and "dense" should be italicized, or otherwise made to show that they refer to a grade, when such is the intention, and that they are not used in the general sense.

Mr. von Schrenk. MR. VON SCHRENK.—The committee very much appreciates such criticisms, and I am sure some of those just mentioned are very well founded. I think that the only reason why some of these words have not been eliminated heretofore, is that they are the result of long standing practice and have simply been reiterated and reiterated. The reason why we did not attempt to make corrections this year, was that we were somewhat afraid that if we made too many changes at present, it might jeopardize the larger purpose. The committee is very glad indeed to entertain these criticisms and will try to correct such faults next year.

REPORT OF COMMITTEE D-8
ON
WATERPROOFING MATERIALS.

Following the last formal report of Committee D-8 in 1913, which was felt to be as exhaustive a declaration as knowledge of the subject then warranted, as a result of a conclusion after much discussion at a subsequent meeting, the membership was materially enlarged last year with the view of carrying on the work of the committee more satisfactorily through a number of sub-committees.

More formal organization was accomplished with the adoption of specific by-laws, providing for the creation of an advisory committee and the fixing of specified regular meetings at which reports of sub-committees must be presented.

The following five sub-committees have been organized to gather information covering the subject of waterproofing materials as directly affecting the classes of construction assigned to each.

I. On Railroad Structures: *Chairman*, L. W. Walter, Assistant Engineer, Erie R. R., Jersey City, N. J.

II. On Subways and Tunnels: *Chairman*, J. Vipond Davies, Consulting Engineer, New York.

III. On Hydraulic Structures: *Chairman*, Morris R. Sherrerd, Chief Engineer, Board of Water Commissioners, Newark, N. J.

IV. On Buildings: *Chairman*, H. A. Hottenroth, Architect, George B. Post & Sons, New York, N. Y.

V. Technical: *Chairman*, Roy O. Fitch, Chemist, Bureau of Standards, Y. M. C. A., Washington, D. C.

Preliminary reports embodying in some cases considerable accumulated data covering specification practices in use have been presented by four of the above sub-committees, with an outline of program of proposed future work.

It is too early to embody any of this matter in a formal report to the Society, but with the contemplated entrance into

the committee's activity of Sub-Committee V, which has been instructed to undertake special work, it is confidently expected that at the next annual meeting Committee D-8 will be in a position to submit specifications.

Reference must be made here as a matter of record before the Society of the action of Committee D-8 in connection with its participation in a conference committee composed of representatives from Committee D-4 on Standard Tests for Road Materials, Committee C-9 on Standard Tests of Concrete and Concrete Aggregates, and Committee D-8 on Waterproofing Materials, to consider proposed standard definitions recommended by Committee D-4 in 1913 and 1914 for adoption by the Society but referred back to the above conference at the last annual meeting of the Society.

Committee D-8 through its representative, Mr. R. J. Wig, voted against the conference committee's definition of "Dust," paragraph (*a*). Committee D-8 has endorsed this negative vote and recommends that the definition be specifically qualified as "Rock Crusher Dust."

Committee D-8 through its representative, Mr. K. G. Mackenzie, voted against the conference committee's definitions of "Solid," "Liquid," and "Semi-Solid" Bituminous Materials. Committee D-8 endorsed this negative vote and recommends that the terms "Solid," "Liquid" and "Semi-Solid" be not at present defined till a more satisfactory method than that proposed for differentiating such bituminous materials shall be devised.

This report has been submitted to letter ballot of the committee, which consists of 26 members, of whom 16 have voted affirmatively, none negatively, and 10 have refrained from voting.

Respectfully submitted on behalf of the committee,

W. A. AIKEN,
Chairman.

CYRILL DE WYRALL,
Secretary.

REPORT OF COMMITTEE D-9

ON

STANDARD TESTS OF INSULATING MATERIALS.

A very considerable amount of work has been done by some of the members of this committee with particular reference to standard tests for molded insulating materials, sheet insulating materials and liquid insulators. The committee has held one meeting during the last year and in spite of the fact that previous progress had not been at all satisfactory, it was voted to continue the work. A Sub-Committee on Porcelain was appointed, but as yet no report has been made.

Trial specifications for molded insulating materials have been submitted to the various members of the committee and to other interested parties.

Trial specifications for sheet insulating materials have been made up and are under test by some of the members of the committee most interested in this particular subject. The committee is not as yet ready to submit tentative specifications to the Society, but should be able to present one or more such specifications next year.

This report has been submitted to letter ballot of the committee, which consists of 11 members, of whom 9 have voted affirmatively, none negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the committee,

C. E. SKINNER,
Chairman.

REPORT OF COMMITTEE D-11

ON

STANDARD SPECIFICATIONS FOR RUBBER PRODUCTS.

Committee D-11 has held one meeting during the year in New York City, which was attended by 13 members in person and 2 by proxy.

Sub-Committee I on Air Hose.—Sub-Committee I submitted the Specifications for Air-Brake Hose of the Master Car Builders' Association for adoption by the committee. The specifications were returned to the sub-committee with the report that the committee felt that the present M. C. B. specifications could be improved in some ways, and although there might be little prospect that improved specifications would be generally adopted at the present time, the Society should adopt the best practical specifications that the committee could prepare, with the hope that such specifications might be used by some of the railroads, and that its adoption by this Society might influence the Master Car Builders' Association to revise their present specification.

Sub-Committee I also submitted proposed Standard Specifications for Pneumatic Tool Hose, which were referred back to the sub-committee with the suggestion that a better quality of hose should be specified.

Sub-Committee II on Belting.—Sub-Committee II has held one meeting during the year and "trial" Specifications on Rubber Power Belting have gone before the members of the sub-committee for their consideration.

Sub-Committee III on Cold-Water Hose.—At the meeting of Committee D-11 held in New York City, Sub-Committee III submitted proposed Standard Specifications for $2\frac{5}{8}$-in. Cotton Rubber-Lined Fire Hose for Private Department Use,

which were adopted unanimously by those present. The specifications were later referred to the whole committee by letter ballot, with the following result: Voted affirmatively, 18; negatively, 2; not voting, 6; no reply, 2. These proposed specifications are appended to this report,[1] and it is recommended that they be referred to letter ballot of the Society for adoption as standard.

After the New York City meeting Sub-Committee III prepared proposed Standard Methods for Testing of Cotton Rubber-Lined Hose, which were referred to the whole committee by letter ballot, with the following result: Voted affirmatively, 14; negatively, 3; not voting, 1; no reply, 9. These methods of test, which consist principally of chemical and physical tests of rubber, are intended primarily for cotton rubber-lined hose, but it is proposed to have Sub-Committee III confer with other sub-committees as fast as additional specifications are prepared so that the proposed methods of tests will also cover the new specifications as fast as they are prepared. The proposed methods of tests are appended to this report,[1] and it is recommended that they be referred to letter ballot of the Society for adoption as standard.

Sub-Committee V on Insulated Wire.—Sub-Committee V has prepared tentative specifications covering both physical requirements and tests for 30-per-cent rubber insulation, under the title of "Specifications for Insulated Wire and Cable: 30 per cent Hevea Rubber," which will be presented to the members of the committee for their ratification as soon as a sub-committee has passed on a procedure for chemical analysis. At the time this report is written it is expected that the specifications in their entirety will be ready to go before Committee D-11 at the annual meeting of the Society, and that they will then be presented to the Society for publication in the Year-Book as tentative.

The other sub-committees have been working on their respective subjects but up to the present have no definite progress to report.

[1] These specifications and methods are not reprinted here, but they appear in the 1915 Year-Book.—Ed.

This report has been submitted to letter ballot of the committee, which consists of 27 members, of whom 19 have voted affirmatively, 1 negatively, and 7 have refrained from voting.

Respectfully submitted on behalf of the committee,

E. A. BARRIER,
Chairman.

F. M. WARING,
Secretary.

[EDITOR'S NOTE.—For action taken on this report, see pages 28–29.

The proposed Standards referred to in the report were adopted by letter ballot of the Society on August 21, 1915, and appear among the Standards in the 1915 Year-Book.

The proposed Tentative Specifications for Insulated Wire and Cable: 30 per cent Hevea Rubber, referred to in the report, were presented at the annual meeting by Committee D-11 and accepted for publication in the Year-Book as tentative provided a subsequent letter ballot of the committee should be in the affirmative without a dissenting vote. This letter ballot was not unanimous, so that the proposed Tentative Standards do not appear in the Year-Book. They are, however, appended to this report.

For Discussion on the report, see page 434.]

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROPOSED TENTATIVE SPECIFICATIONS FOR INSULATED WIRE AND CABLE: 30 PER CENT HEVEA RUBBER.[1]

Criticisms of these proposed Tentative Specifications are solicited and should be directed, preferably before January 1, 1916, to Mr. E. A. Barrier, Chairman of Committee D-11 on Standard Specifications for Rubber Products, 31 Milk Street, Boston, Mass.

1. These specifications cover conductors and rubber insulation only. **Scope.**

(*A*) *Conductor.*

I. MANUFACTURE.

2. The conductor shall be made of soft annealed copper, properly tinned, and have the properties and characteristics herein required. **Material.**

3. (*a*) Each solid conductor or individual wire of a stranded conductor shall be considered separately and shall be designated as a strand. **Strand.**

(*b*) The stranding shall be concentric, unless otherwise specified, and shall conform to Table I.

4. Each strand shall be round and reasonably free from imperfections. **Shape.**

[1] These specifications do not appear in the 1915 Year-Book among the Tentative Standards for reasons explained on the preceding page.—ED.

Specific Gravity.

5. For the purpose of calculating weights, cross-sections, etc., the specific gravity of the copper shall be the same as recommended in the standardization rules of the American Institute of Electrical Engineers. See Appendix I.

TABLE I.—STRANDING.

(ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.)

Sizes.	Minimum Number of Strands in Conductor.
2 000 000 to 1 600 000 C. M.	127
1 500 000 " 1 100 000 "	91
1 000 000 " 550 000 "	61
500 000 " 250 000 "	37
No. 0000 " No. 1 A. W. G. or B. & S.	19
No. 2 " No. 8 " "	7
Smaller sizes	1

II. PHYSICAL PROPERTIES AND TESTS.

Tensile Properties.

6. Each strand shall be so drawn and annealed that after tinning it shall conform to the properties given in Table II.

TABLE II.—TENSILE PROPERTIES.

(AMERICAN SOCIETY FOR TESTING MATERIALS.)

Diameter, in.	Maximum Tensile Strength, lb. per sq. in.	Minimum Elongation in 10 in., per cent.
0.460 to 0.290	36 000	35
0.289 " 0.103	37 000	30
0.102 " 0.021	38 500	25
0.020 " 0.003	40 000	20

Tension Tests.

7. Tension tests shall be made on fair samples and the elongation shall be determined as the permanent increase in length, due to the breaking of the wire in tension, measured between bench marks originally 10 in. apart. The specimen shall break between the bench marks and not closer than 1 in. to either mark.

Number of Tests.

8. Samples shall be taken in accordance with Section 17.

Retests due to Failure in Tensile Strength.

9. If upon testing a sample from a coil, reel or spool of wire, the results are found to be above the stated value for tensile strength or below the value for elongation, tests upon two additional samples will be made, and the average of the three tests shall determine acceptance or rejection.

Conductivity.

10. The conductivity of the copper shall not be less than 98 per cent of the annealed copper standard. See Appendix I.

Tinning Test.

11. Each sample before stranding or insulating shall be given the following tests at the factory:

(*a*) *Preparation.*—The sample shall be thoroughly cleaned by immersing in redistilled petroleum ether, followed by immersion in 95-per-cent alcohol. The sample shall then be immersed in hydrochloric acid (sp. gr. 1.088) at a temperature of from 60 to 70° F. for one minute, washed in distilled water (the surplus water shaken off) and immersed in a solution of sodium sulfide for 30 seconds and again washed in water (the surplus water shaken off). The above operation shall be repeated four times for samples 0.02 in. in diameter or over, and three times for samples less than 0.02 in. in diameter. After the completion of the required number of cycles the samples shall not show any sign of blackening in the air, which is perceptible to the eye.

(*b*) *Strength of Solution.*—The solution of sodium sulfide shall have sufficient strength to thoroughly blacken in 5 seconds a piece of untinned copper wire that has previously been cleaned in 95-per-cent alcohol. The solution shall be prepared by thoroughly saturating (by boiling) a solution of sodium monosulfide with sulfur and shall have a specific gravity of 1.142 at 60° F. (15°.55 C.).

(*c*) *Number of Tests.*—Samples shall be taken in accordance with Section 17.

(*d*) *Retests.*—If the specimen tested in accordance with Paragraph (*a*) shows any sign of blackening whatever, two more specimens shall be tested. If one of these two additional specimens shows any sign of blackening whatever, that coil or reel shall be rejected. If both specimens are free from any signs of blackening, the coil or reel shall be accepted. If more than 10 per cent of the samples in the entire order fail, all of the wire shall be rejected. If 10 per cent or less of the samples

in the entire lot fail, each coil, reel or length may be tested and accepted or rejected upon the results of the individual tests.

III. PERMISSIBLE VARIATIONS.

Permissible Variations.

12. (*a*) Permissible variations from the specified diameter of the strand shall not exceed 1 per cent under or 2 per cent over for wire 0.02 in. in diameter and larger, and 0.1 mil under for wire less than 0.02 in. in diameter.

(*b*) When wire is submitted in coils, each coil shall be gaged in three places, one near each end and one approximately at the middle. When the wire is submitted on spools or reels, approximately 12 ft. of the wire shall be reeled off and the wire then gaged in six places between the second foot and the twelfth foot from the end.

(*c*) The coils or reels shall be rejected if the average of the measurements obtained in accordance with Paragraph (*b*) are not within the limits specified in Paragraph (*a*) or if any individual measurement is not within twice the limits specified in Paragraph (*a*).

(*B*) *Insulation.*

IV. CHEMICAL PROPERTIES AND TESTS.

Rubber Compound.

13. (*a*) The insulation shall contain exclusively from 30 to 33 per cent, by weight, of Hevea rubber, which has not been previously used, waxy hydrocarbons consisting of ceresine or refined paraffin, sufficient sulfur to properly vulcanize, and fillers which are entirely inorganic mineral matter containing no red lead, carbon or bitumen.

(*b*) As required in Section 21 (*e*), the vulcanized compound shall conform to the following requirements expressed as percentages, by weight, of the whole sample:

	Maximum.	Minimum.
Rubber, per cent	33	30
Waxy hydrocarbons, per cent	4	..
Free sulfur, per cent	0.7	..

Results shall be taken between the limits given in proportion to the percentage by weight of the rubber found.

The limits allowed for 30-per-cent rubber compound shall be as follows:

	MAXIMUM.	MINIMUM.
Saponifiable acetone extract	1.35	0.55
Unsaponifiable resins	0.45	..
Chloroform extract	0.90	..
Alcoholic potash extract	0.55	..
Total sulfur (see note)	2.10	..
Specific gravity	..	1.75

The limits allowed for 33-per-cent rubber compound shall be as follows:

	MAXIMUM.	MINIMUM.
Saponifiable acetone extract	1.50	0.60
Unsaponifiable resins	0.50	..
Chloroform extract	1.00	..
Alcoholic potash extract	0.60	..
Total sulfur (see note)	2.30	..
Specific gravity	..	1.67

The acetone solution shall not fluoresce.

The acetone extract (60 cc.) shall not be darker than a light straw color.

Hydrocarbons shall be solid, waxy and not darker than a light brown.

Chloroform extract (60 cc.) shall not be darker than a straw color.

Contamination of the compound, such as by the use of impregnated tapes, will not excuse the manufacturer from conforming to this specification.

NOTE.—The limit on total sulfur may be omitted at the option of the purchaser. The compound shall be analyzed by the procedure recommended by the Joint Rubber Insulation Committee. See Appendix II.

NOTE.—The purchaser and manufacturer shall agree upon the method to be used in the determination of the fillers.

V. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

14. The test specimen shall have the following physical properties:

Tensile strength, min., lb. per sq. in.	1000
Set, max., in.	not over $\frac{1}{8}$
Elongation, in.	2–9

Method of Making Physical Tests.

15. (*a*) *Tension Test.*—A test specimen having a length of not less than 6 in., marked with bench marks 2 in. apart, shall be placed in the jaws of a testing machine (maximum distance between jaws holding test specimen, 4 in.) and stretched at the rate of 20 in. per minute (jaw speed) until the specimen breaks. The test specimen shall break between the bench marks, and the tensile strength shall be calculated upon the area of the original sample.

(*b*) *Stretching Test.*—A second test specimen having a length of not less than 6 in., marked with bench marks 2 in. apart, shall be placed in the jaws of a testing machine (maximum distance between jaws holding test specimen, 4 in.) and stretched at the rate of 20 in. per minute (jaw speed) until the bench marks are 6 in. apart. After the termination of this stretch, the test specimen shall be released within 5 seconds and the set determined one minute after the beginning of release.

(*c*) *Elongation Test.*—After the determination of the set in accordance with Paragraph (*b*), the specimen shall be placed in the jaws of a testing machine (maximum distance between jaws holding test specimen, 4 in.) and stretched at the rate of 20 in. per minute (jaw speed) until it breaks. The test specimen shall break between the bench marks.

(*d*) *Retests.*—If the specimen fails to pass in either of the above three tests, two more specimens shall be taken from the same sample and the average of the results shall determine whether the material complies with the requirements.

NOTE.—All physical tests shall be made at a room temperature of from 65 to 85° F. (18.33 to 29°.44 C.), inclusive, and the test specimen shall have been kept at the room temperature not less than 30 minutes prior to the tests.

(*e*) *Accuracy of Machine.*—The test machine shall be accurate within one per cent of the breaking load.

(*f*) *Jaws.*—The jaws of the machine shall be of an approved type.

Test Specimen.

16. (*a*) The test specimen may be the entire section of the insulation in the case of small wire, or in the case of a large wire, a segment of a section, cut with a sharp knife held tangentially to the conductor. The test specimen shall be as free as possible from surface incisions and imperfections.

(*b*) In event of any irregularities on the surface of the test specimen, it shall be made smooth and of uniform thickness within 5 per cent of the original thickness by buffing, except when large strands are used, in which case the rubber sample shall be buffed sufficiently to remove all corrugations.

(*c*) There shall be no limit to the cross-section of the test specimen, except as restricted by the capacity of the testing machine.

(*d*) Calculation of the area of test specimen shall be made, as follows:

(1) When the total cross-section of the insulation is used, the area shall be calculated as the area of the circle whose diameter is the minimum average outside diameter of the insulation minus the area of the conductor. The area of a stranded conductor shall be figured from its maximum diameter.

(2) When a slice cut from the wire by a knife held tangent to the wire is used, and the resulting cut is straight, the area shall be calculated as that of the segment of a circle whose diameter is that of the insulation. The height of the segment is the wall of insulation on the side from which the slice is taken. (The values are most easily obtained from a table giving the areas of segments of a unit circle for the ratio of the height of the segment to the diameter of the circle.)

(3) If the insulation is somewhat elliptical or the cut by the knife is not straight, the area shall be calculated from a direct measurement of the volume or from the specific gravity and the weight of a known length of a uniform cross-section.

(4) When a portion of a sector of a circle has to be taken (as in the case of large conductors with thin walls) the area shall be calculated as the thickness times the width. (This applies either to a straight test specimen or one stamped out with a die, and assumes that corrugations have been removed by buffing.)

(5) When a portion of a sector of a circle has to be taken on large conductors with thick walls the area shall be calculated as the proportional part of the area of the total cross-section.

Number of Physical Test Specimens.

17. (*a*) When an order calls for less than 500 ft., physical tests shall be waived.

(*b*) When the order calls for 500 ft. or more and is made into one or more coils, reels or lengths, samples shall be taken from 10 per cent of the coils, reels or lengths, but in all cases there shall be one sample taken.

Rejection based on Physical Tests.

18. All coils, reels or lengths shall be rejected if more than 10 per cent of the samples in the entire order fail. If 10 per cent or less fail, each coil, reel or length may be tested and shall be accepted or rejected upon the results of individual test.

TABLE III.—VALUES OF TEST POTENTIALS, IN KILOVOLTS.

(ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.)

Size of Conductors.	Thickness of Insulation, 64ths In.							
	2	3	4	5	6	7	8	10
18 A. W. G. or B. & S.	1.0	2.5	4.5	5.5	6.5	7.5	8.5	10.5
16 " "	1.0	2.5	4.5	5.5	6.5	7.5	8.5	10.5
14 " "	...	2.5	5.0	6.0	7.0	8.0	9.0	11.0
12 " "	...	2.5	5.0	6.0	7.5	8.5	9.5	11.5
10 " "	...	3.0	5.0	6.5	8.0	8.5	10.0	12.0
8 " "	...	3.0	5.0	7.0	8.0	9.5	11.0	13.0
6 " "	...	...	5.0	6.5	8.5	10.0	11.5	14.0
4 " "	...	...	4.5	6.5	8.5	10.0	11.5	14.5
2 " "	...	...	4.0	6.0	8.0	10.0	12.0	15.0
0 " "	...	...	...	5.5	8.0	10.0	12.0	15.5
00 " "	...	...	...	5.0	7.5	9.5	11.5	15.5
000 " "	...	...	...	5.0	7.5	9.5	11.5	15.5
0000 " "	...	...	...	4.5	7.0	9.0	11.5	15.5
250 000 C. M.	...	...	...	4.0	6.5	9.0	11.0	15.5
500 000 "	...	...	...	2.5	5.0	7.5	10.0	14.5
750 000 "	...	...	...	...	...	6.5	9.0	14.0
1 000 000 "	...	...	...	...	...	5.5	8.0	13.0
1 250 000 "	...	...	...	...	...	...	7.5	12.5
1 500 000 "	...	...	...	...	...	...	7.0	12.0
1 750 000 "	...	...	...	...	...	...	6.5	11.5
2 000 000 "	...	...	...	...	...	...	5.0	10.5

VI. ELECTRICAL PROPERTIES AND TESTS.

Electrical Properties.

19. (*a*) *Place.*—All electrical tests shall be made at the factory.

(*b*) *Preparation.*—Every coil, reel or length of wire, after vulcanization and before the application of paraffin or any covering other than tape or braid, used in vulcanization, shall successfully withstand a high-voltage test as specified in Table III, and shall have an insulation resistance not less than that specified in Table IV. The high-potential test shall be made after not less than 18 hours submersion in water, and while still submerged.

TABLE IV.—INSULATION RESISTANCE, IN MEGOHM-MILES AT 60° F.[1]

(ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.)

Size of Conductors.	Thickness of Insulation, 64ths In.																
	2	3	4	5	6	7	8	10	12	14	16	18	20	22	24	26	28
18 A. W. G. or B. & S.	1 600	2 050	2 450	2 800	3 000	3 200	3 400	3 750	4 050	4 300	4 500	4 700	4 900	5 000	5 150	5 300	5 400
16 " "	1 400	1 800	2 150	2 400	2 650	2 850	3 050	3 400	3 650	3 950	4 150	4 350	4 500	4 650	4 800	4 900	5 050
14 " "	....	1 530	1 850	2 150	2 350	2 550	2 650	3 050	3 350	3 550	3 800	3 950	4 100	4 300	4 400	4 550	4 650
12 " "	....	1 350	1 600	1 850	2 050	2 250	2 400	2 750	3 000	3 250	3 400	3 600	3 750	3 900	4 050	4 150	4 300
10 " "	....	1 150	1 350	1 600	1 800	2 000	2 150	2 400	2 650	2 900	3 100	3 250	3 400	3 550	3 700	3 800	3 900
8 " "	....	850	1 050	1 250	1 450	1 650	1 750	2 050	2 200	2 400	2 600	2 750	2 900	3 050	3 150	3 250	3 350
6 " "	....	....	850	1 050	1 200	1 350	1 450	1 750	1 950	2 100	2 300	2 450	2 550	2 700	2 800	2 900	3 000
4 " "	....	....	750	850	1 000	1 150	1 250	1 450	1 650	1 850	2 000	2 150	2 250	2 400	2 500	2 600	2 700
2 " "	....	....	650	750	850	950	1 050	1 250	1 450	1 600	1 700	1 850	1 950	2 100	2 200	2 300	2 400
1 " "	....	....	600	650	750	850	1 000	1 150	1 350	1 450	1 600	1 750	1 850	1 950	2 050	2 150	2 250
0 " "	....	....	....	600	700	800	950	1 050	1 200	1 350	1 500	1 600	1 700	1 800	1 900	2 000	....
00 " "	....	....	....	550	650	750	850	950	1 050	1 250	1 350	1 500	1 600	1 700	1 800	....	....
000 " "	....	....	....	500	600	650	750	850	1 000	1 150	1 250	1 350	1 450	1 550	....	....	....
0000 " "	....	....	....	450	550	600	650	800	950	1 050	1 150	1 250	1 350	1 450	....	....	....
250 000 C. M.	....	....	....	400	475	575	625	725	875	1 000	1 100	1 200	1 275	....	....	....	....
350 000 "	....	....	....	350	425	475	525	675	775	850	950	1 050	1 125	....	....	....	....
500 000 "	....	....	....	300	375	400	475	575	675	750	850	900	....	....	....	....	....
750 000 "	....	....	....	....	....	325	400	475	525	625	700	775	....	....	....	....	....
1 000 000 "	....	....	....	....	....	300	325	400	475	550	625	....	....	....	....	....	....
1 250 000 "	....	....	....	....	....	....	325	375	425	500	575	....	....	....	....	....	....
1 500 000 "	....	....	....	....	....	....	300	325	400	475	....	....	....	....	....	....	....
1 750 000 "	....	....	....	....	....	....	275	300	375	450	....	....	....	....	....	....	....
2 000 000 "	....	....	....	....	....	....	200	275	325	425	....	....	....	....	....	....	....

NOTE.—For intermediate sizes, use values of next larger size.

[1] This table is based on the constant 4000 in the following formula:

$R = K \log \frac{D}{d}$, where R = resistance in megohms, K = Constant, D = diameter over insulation, d = diameter over conductor.

(*c*) *High-Potential Test.*—The test voltage shall be applied for five minutes and the frequency of the test voltage shall be in accordance with the standardization rules of the Ame ican Institute of Electrical Engineers. See Appendix I.

(*d*) This test shall be in accordance with the standardization rules of the American Institute of Electrical Engineers. See Appendix I.

(*e*) The insulation resistance (megohms) shall be reduced to that at 60° F. (15°.66 C.) by multiplying by the coefficient in Table V, corresponding to the temperature at which test is made.

TABLE V.—COEFFICIENTS.

(TESTS SHALL BE MADE AT TEMPERATURES WITHIN THE SCOPE OF THIS TABLE.)

Temperature.		Coefficient.	Temperature.		Coefficient.
Deg. Fahr.	Deg. Cent.		Deg. Fahr.	Deg. Cent.	
..	....		..	....	1.000
46	7.8	0.694	61	16.1	1.026
47	8.3	0.709	62	16.7	1.053
48	8.9	0.729	63	17.2	1.081
49	9.4	0.746	64	17.8	1.109
50	10.0	0.769	65	18.3	1.138
51	10.6	0.787	66	18.9	1.169
52	11.1	0.806	67	19.4	1.200
53	11.7	0.833	68	20.0	1.231
54	12.2	0.854	69	20.6	1.264
55	12.8	0.877	70	21.1	1.297
56	13.3	0.900	71	21.7	1.331
57	13.9	0.917	72	22.2	1.366
58	14.4	0.943	73	22.8	1.402
59	15.0	0.970	74	23.3	1.438
60	15.6	1.000	75	23.9	1.477

Rejection based on Electrical Tests.

20. Every coil, reel or length shall be rejected if it fails to withstand the electrical requirements herein specified.

(*C*) *Inspection.*

Inspection.

21. (*a*) The manufacturer shall notify the purchaser sufficiently in advance of the completion of the wire or cable to permit of arrangement for the inspection.

(*b*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the wire ordered,

except compounding room. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the wire is being furnished in accordance with these specifications. Tests and inspection shall be made prior to shipment, at the place of manufacture.

(*c*) The purchaser may make the tests to govern the acceptance or rejection of the wire in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(*d*) After the material has passed all physical and electrical requirements, and before braiding, the purchaser may take samples for chemical analysis in accordance with Section 17.

(*e*) The purchaser may make chemical analysis on any one or more of the samples so selected to determine if the compound meets the requirements in Section 13 (*b*).

(*f*) Failure of any one sample selected shall be sufficient cause to reject the wire which the sample represents except in the case of failure to meet the requirements of either or both free sulfur and chloroform extractive in accordance with Section 13 (*b*). In case of such failure the coil from which the sample was taken shall be rejected and two additional samples taken from the remainder of the order. The remainder of the order shall be accepted if both samples so selected shall meet the requirements for free sulfur or chloroform extractive in accordance with Section 13 (*b*). The entire order shall be rejected if either sample fails to meet the requirements.

22. Samples of rejected material shall be preserved for two weeks from date of test report. In case of dissatisfaction with the results of tests, the manufacturer may make claim for a rehearing within that time. **Rehearing.**

APPENDIX I.

STANDARDIZATION RULES OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

CONDUCTIVITY OF COPPER.

1. The following shall be taken as normal values for standard annealed copper:

(*a*) At a temperature of 20° C. the resistance of a wire of standard annealed copper one meter in length and of a uniform section of 1 sq. mm. is 1/58 ohm = 0.017241 ohm.

(*b*) At a temperature of 20° C. the density of standard annealed copper is 8.89 g. per cc.

(*c*) At a temperature of 20° C. the "constant mass" temperature coefficient of resistance of standard annealed copper, measured between two potential points rigidly fixed to the wire, is 0.00393 = 1/254.45... per degree Centigrade.

(*d*) As a consequence, it follows from (*a*) and (*b*) that, at a temperature of 20° C., the resistance of a wire of standard annealed copper of uniform section, one meter in length and weighing one gram, is $(1/58) \times 8.89 = 0.15328...$ ohm.

FREQUENCY.

2. The frequency of the test voltage shall not exceed 100 cycles per second, and should approximate as closely as possible to a sine wave. The source of energy should be of ample capacity.

TEST.

3. The insulation resistance should be measured after the dielectric-strength test, measuring the leakage current after a one-minute electrification, with a continuous electromotive force of from 100 to 500 volts, the conductor being maintained positive to the water.

APPENDIX II.

JOINT RUBBER INSULATION COMMITTEE PROCEDURE FOR THE ANALYSIS OF RUBBER COMPOUND.

Object of the Analysis.

1. The object of this procedure of analysis is to determine whether rubber compounds comply chemically with the accompanying specification which is intended to secure compounds containing 30 per cent of the best Hevea rubber, and mineral fillers.

Outline of Procedure.

2. The general procedure is shown in Fig. 1, which gives an outline of the separations to be effected by acetone and chloroform extractions, and saponification with alcoholic potash.

General.

3. Make the analysis upon the insulation after vulcanization and, whenever possible, before the saturation of the braid. Wipe the insulation thoroughly with a damp cloth to remove any adhering material, but do not remove waxy hydrocarbons from the surface.

4. If, however, a saturated braided sample must be used, remove the braid and sandpaper the insulation to a depth of 0.005 in. and wipe with a damp cloth. In such cases report the condition of the sample.

5. Perform all determinations in duplicate and take the average value arbitrarily as the true value. Duplicate determinations must check within the limits specified.

6. Make blanks on all determinations and deduct the results accordingly.

7. Remove the insulation entirely from sufficient wire to give a sample weighing about 25 g. Cut this into small strips

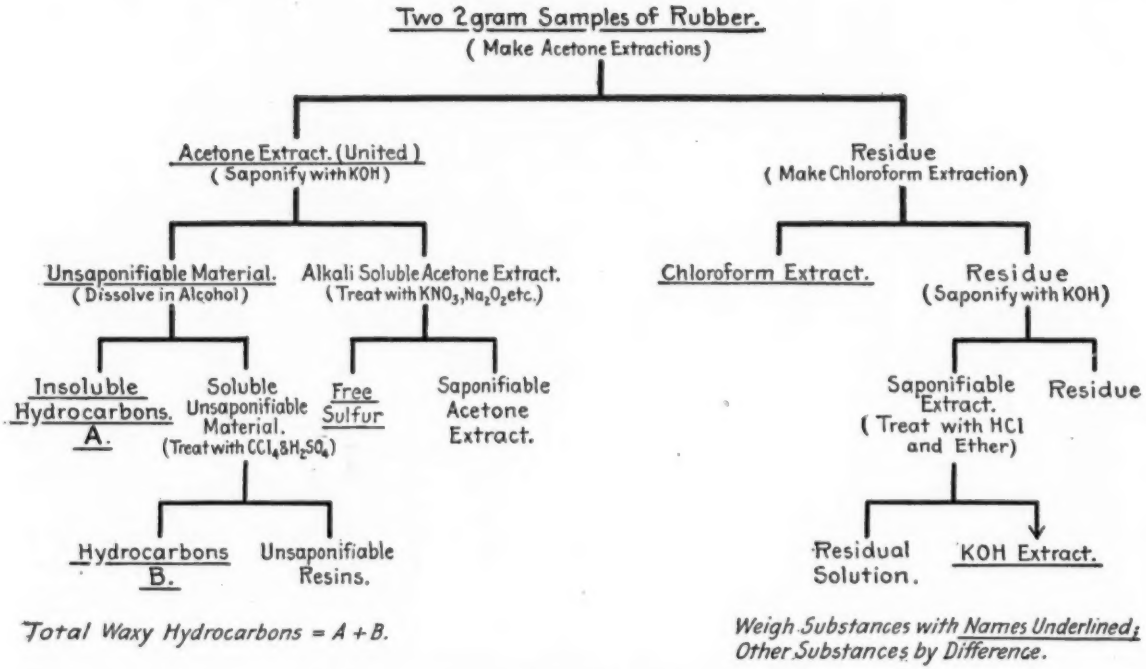


FIG. 1.—Outline of Method for Rubber Analysis.
(Exclusive of Fillers and Total Sulfur Determinations.)

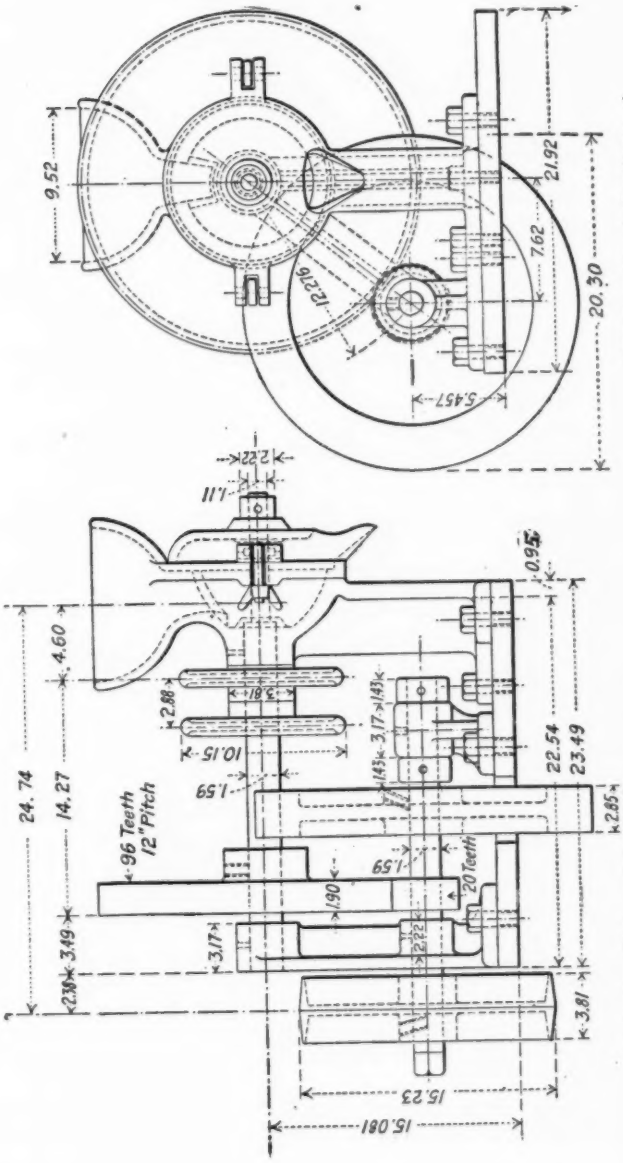
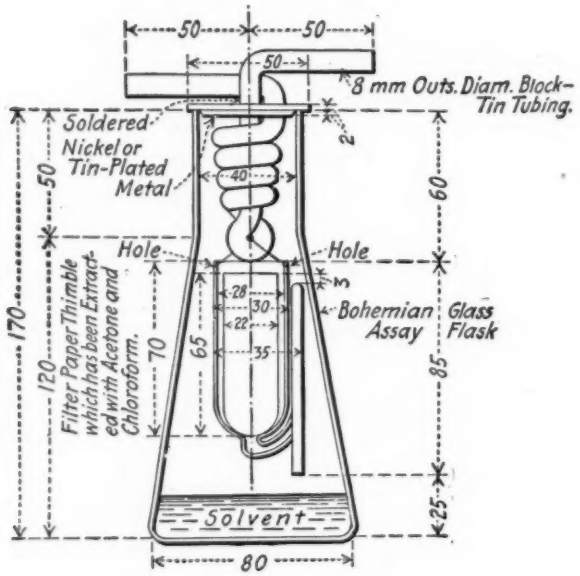


FIG. 2.—Rubber Grinder.

and grind slowly in either a No. 0 Enterprise coffee mill or a mill such as shown in Fig. 2. Adjust the grinder so that not more than 20 per cent will pass through a 40-mesh sieve. Sift all the material through a 20-mesh sieve, regrinding what is retained on the sieve until the entire sample has passed through. The wires of the sieves shall be evenly spaced in both directions and shall be of 0.016 and 0.010 in. diameter in the 20 and 40-mesh sieves, respectively. Remove with a strong magnet any



(All dimensions in millimeters.)

FIG. 3.—Extraction Apparatus.

metal that may have come from the grinder and thoroughly mix the sample.

EXTRACTION APPARATUS.

8. The extraction apparatus shall conform with Fig. 3. It shall be heated so that the period of filling an empty syphon cup with acetone and completely emptying it, will be between 2½ and 3½ minutes.

PREPARATION OF REAGENTS.

9. Acetone shall be freshly distilled over anhydrous K_2CO_3, using the fraction 56–57° C. **Acetone.**

10. Alcoholic KOH solution shall be of normal strength and shall be made freshly by dissolving the proper amount of KOH (purified by alcohol) in 95-per-cent alcohol which has previously been distilled over KOH. The solution shall be allowed to stand for 24 hours and only the clear liquid used. **Alcoholic Potash.**

11. Ether shall be washed with three successive portions of distilled water and distilled, using the fraction 34–36° C. **Ether.**

12. Chloroform shall be pure and freshly distilled. **Chloroform.**

13. Carbon tetrachloride shall be pure and freshly distilled. **Carbon Tetrachloride.**

14. Reagents not otherwise specified shall be c.p.

ACETONE EXTRACTION.

15. Extract continuously with 60 cc. of acetone for eight hours, two 2-g. samples that have been prepared within 24 hours. Unite the extracts in a weighed flask, using hot chloroform to rinse the flasks. Distill off the reagents and dry the flask and contents for 4 hours at 95 to 100° C. Desiccate until cool and weigh. Continue to dry for 2-hour periods until constant weight is obtained. In drying, place the flask on its side but in a sufficient angle from the horizontal so that the extract does not appreciably run down the side of the flask.

UNSAPONIFIABLE MATERIAL.

16. Add to the acetone extract 50 cc. of alcoholic KOH solution, boil under a reflux condenser for 2 hours, and evaporate to dryness, removing all alcohol. Add 10 cc. of water and 20 cc. of ether; heat until the wax, etc., are in solution, cool, transfer to a separatory funnel, wash out the flask with warm water and then cool finally with two 20-cc. portions of ether. The water volume should be 100 cc. and the ether at least 40 cc. Shake vigorously for two minutes, and allow the solution to separate thoroughly. Draw off the aqueous solution into a second funnel, leaving in the first funnel the etherial solution and any flocculent material that may be present. Again rinse the flask with 20 cc. of ether and add it to the aqueous solution;

shake vigorously for 2 minutes, and when separated draw off the aqueous solution and unite in the first funnel the etherial solutions and any flocculent material. Repeat, shaking with 20-cc. portions of ether until the extraction is complete, using at least 120 cc. of ether. Wash the flask and the funnel, from which the etherial solution has been taken, with water, until they are free from alkali, subsequently using this wash water to wash the etherial solution. Continue washing with water until it has been washed twice after it shows no alkaline reaction. Retain with the etherial solution any flocculent material. Filter the etherial solution from the flocculent material, through a small pellet of extracted cotton, into a weighed flask, washing first with ether and subsequently with hot chloroform, using this to rinse the original flask and both separatory funnels. Evaporate the solvents and dry the extract to constant weight at 95 to 100° C. Cool in a desiccator and weigh.

HYDROCARBONS "A".

17. Add 50 cc. of absolute alcohol to the unsaponifiable material and warm until solution is as complete as possible. Cool the solution to −4 or −5° C. and maintain at this temperature for the hour by packing the flask in a mixture of ice and salt. Filter out the waxy hydrocarbons, using a funnel packed with ice and salt, and apply suction if necessary. Wash the flask and filter with about 25 cc. of 95-per-cent alcohol, which has been previously cooled in the same temperature. Catch the filtrate in a flask which is afterwards cooled to −4 or −5° C. to make sure that all possible waxy hydrocarbons have been removed, and refilter if necessary. Dissolve the residue on the filter paper with hot chloroform, into the original flask. Evaporate the chloroform and dry the flask to constant weight at 95 to 100° C. Cool in a desiccator and weigh.

HYDROCARBONS "B".

18. Evaporate the alcohol from the flask containing the alcohol-soluble unsaponifiable material, add 25 cc. of carbon tetrachloride and transfer to a separatory funnel. Shake with concentrated H_2SO_4, drain off the discolored acid and repeat

with fresh portions of acid until there is no longer any discoloration. After drawing off all the acid, wash the carbon tetrachloride solution with repeated portions of water until all traces of acid are removed. Transfer the carbon tetrachloride solution to a weighed flask; evaporate off the solvent and dry the flask to constant weight at 95 to 100° C. Cool in a desiccator and weigh.

FREE SULFUR.

19. Add 2 g. of KNO_3 to the aqueous solution and washings from the etherial separation of the unsaponified material. Evaporate to dryness in a silver or nickel dish and heat to quiet fusion, avoiding contamination with sulfur fumes. Transfer with water to an evaporating dish, acidify with HCl, evaporate to dryness, and dehydrate silica. Add 2 cc. of concentrated HCl, take up in water, filter and wash, making a volume of 200 cc. Heat to boiling and add slowly a slight excess of hot 10-per-cent $BaCl_2$ solution. Allow to stand over night, filter, wash, ignite, weigh the $BaSO_4$, and calculate to sulfur.

DEFINITION OF TERMS DESCRIBING COMPOUNDS OF ACETONE EXTRACT.

20. The difference between the Acetone Extract and the Free Sulfur shall be called the Organic Extract.

21. The difference between the Organic Extract and the Unsaponifiable Material shall be called the Saponifiable Acetone Extract.

22. The sum of the Hydrocarbons A and B shall be called the total Waxy Hydrocarbons.

23. The difference between the Unsaponifiable Material and the Waxy Hydrocarbons shall be called Unsaponifiable Resins.

CHLOROFORM EXTRACTION.

24. Extract continuously the residue from one of the acetone extractions (without necessarily removing the acetone that may be on it), for 4 hours with 60 cc. of chloroform, using a weighed flask. Distill off the solvent and dry the flask and

contents for 2 hours at 95 to 100° C. Desiccate until cool and weigh. Continue to dry for one-hour periods until constant weight is obtained. In drying, place the flask on its side but at a sufficient angle from the horizontal so that the extract does not appreciably run down the side of the flask. (If it is needful to wait after the acetone extraction, before starting the chloroform extraction, the sample must be kept in a vacuum of at least 50 mm. of mercury.)

ALCOHOLIC-POTASH EXTRACTION.

25. Dry the residue from the chloroform extraction at 50 to 60° C., put into a 200-cc. Erlenmeyer flask with 50 cc. of alcoholic KOH solution and boil for 4 hours under a reflux condenser. Filter the solution into a beaker and wash twice, using each time 25 cc. of hot absolute alcohol and then wash thoroughly with hot water. Evaporate the solution to approximate dryness, take up in warm water and transfer to a separatory funnel. Acidify with 15 cc. of 5 normal HCl, using this to rinse the beaker. Add sufficient water to make the bulk of the solution 100 cc. When cool add 40 cc. of ether, using it to rinse the beaker in 20-cc. portions. Shake the aqueous and etherial solutions thoroughly. After complete separation, draw off the aqueous solution and treat in another separatory funnel, with a fresh 20-cc. portion of ether. Continue to shake the aqueous solution with fresh portions of ether until a colorless portion has been obtained, then shake out twice more. Unite the etherial solutions and wash with successive additions of water, continuing twice after the water shows no acid reaction. Filter through a plug of extracted cotton into a tared flask, wash the filter and funnel with ether, evaporate the ether without boiling and dry the residue to constant weight at 95 to 100° C. Cool in a dessiccator and weigh.

FILLERS.

26. The determination of fillers shall be made by a procedure to be agreed upon by the manufacturer and purchaser.

SULFUR IN FILLERS.

27. Transfer the fillers from the filter paper into an iron crucible; burn the filter paper and add the ash to the crucible. Add the total sulfur flux and proceed with the determination of sulfur as in Section 28, Subtract the percentage of sulfur found from the percentage of fillers to determine the percentage of fillers free from sulfur.

TOTAL SULFUR.

28. Mix a 0.5-g. sample with 4 g. of Na_2O_2 and 6 g. of K_2CO_3 in a dry 15-cc. iron crucible. Cover and heat gradually until the mixture fuses, proceeding cautiously, as rapid heating will cause an explosion, and then bring to a quiet fusion for 15 to 20 minutes. Apply the heat so as to avoid contamination with sulfur fumes. Rotate the crucible while the melt solidifies. When cool, put crucible and cover into a casserole containing 200 cc. of water; add 5 to 10 cc. of bromine water and boil until the melt is dissolved. Allow the precipitate to settle, decant the liquid through a thick filter and wash the residue with hot water. Acidify the filtrate with HCl, evaporate to dryness and dehydrate silica; add 2 cc. of concentrated HCl, take up in water, filter and wash, making the total volume about 400 cc. Heat to boiling and add slowly a slight excess of hot 10-per-cent $BaCl_2$ solution. Allow to stand over night, filter, wash, ignite, weigh the $BaSO_4$ and calculate to sulfur.

SPECIFIC GRAVITY.

29. The specific gravity shall be the ratio of the weight of a given volume of rubber, to the weight of an equal volume of water, both at 20° C. Cut strips of the largest applicable size from the conductor and use about 5 g. for the sample. Determine the specific gravity in the usual manner by means of a specific-gravity bottle. Care must be taken that no air bubbles adhere to the sample.

CHECKS.

30. Specific gravity determinations shall check within 0.01. The other duplicate determinations shall check within

the following limits expressed as percentages of the original sample:

DETERMINATION.	CHECK.
Acetone extract	0.10
Saponifiable-acetone extract	0.10
Unsaponifiable resins	0.10
Waxy hydrocarbons	0.10
Free sulfur	0.05
Chloroform extract	0.10
Alcoholic-potash extract	0.10
Fillers, free from sulfur	0.50
Total sulfur	0.10

INTERPRETATION.

31. The Rubber shall be considered to be the difference between 100 and the sum of the Waxy Hydrocarbons, Total Sulfur and the Fillers (free from sulfur), expressed as percentages. If the Chloroform Extract is over 3.0 per cent of the Rubber so calculated, subtract the excess from the Rubber. If the KOH extract is over 1.8 per cent of the Rubber, as first calculated, subtract this excess also from the Rubber.

CARBON AND RED LEAD.

32. Heat about one gram of the sample with 30 cc. of concentrated HNO_3 and 15 cc. of water. A black insoluble residue indicates the presence of carbon.

When the rubber is dissolved, in the fillers determination, the absence of any red particles indicates the absence of red lead. If red particles are present, dissolve another sample by the same method as the fillers (Section 26), filter the solution into a Gooch crucible and wash thoroughly. Remove the felt and residue to a distilling flask, add HCl, and distill over the chlorine liberated by the lead peroxide, absorbing the gas in a solution of KI and starch. Not more than 0.1 cc. of N/10 thiosulfate shall be required to titrate the iodine liberated.

STATEMENT OF RESULTS.

33. The results of the analysis shall be stated in the following form:

	PER CENT.
Acetone extract	....
Saponifiable-acetone extract	....
Unsaponifiable resins	....
Waxy hydrocarbons	....
Free sulfur	....
Chloroform extract	....
Alcoholic-potash extract	....
Fillers, free from sulfur	....
Total sulfur	....
Rubber	....
Color of acetone extract (60 cc. vol.)	....
Fluorescence in acetone-extract solution (present or absent)	....
Hydrocarbons A (consistency and color)	....
Hydrocarbons B (solid or liquid)	....
Color of chloroform extract (60 cc. vol.)	....
Carbon (present or absent)	....
Red lead (present or absent)	....
Specific gravity	....

DISCUSSION.

Mr. Howard. MR. J. W. HOWARD.—I understand that the chemical tests are still under advisement: for instance, the requirement that "the organic-acetone extract shall not exceed 5 per cent of the gum as found by chemical analysis," this being a test of the rubber lining. Does the proposed standard carry this test with it, or do I understand that the chemical test for rubber and rubber compounds is to be considered later?

Mr. Barrier. MR. E. A. BARRIER (*Chairman of Committee D-11*).—That is only true of the insulated wire. As far as the test for the rubber lining of the fire hose is concerned, we consider that for the present, at least, those are in final form. Of course, we expect to revise these specifications from time to time as the progress and the art of testing rubber is advanced, but for the present, we consider the procedure for the chemical analysis of the rubber lining of fire hose as fixed. The specifications for insulated wire and cable, however, are merely tentative.

Mr. Howard. MR. HOWARD.—I am making a series of chemical and service tests of rubber compounds of the usual types and of special hydrocarbon preservatives and strengtheners in combination with rubber to which the proposed acetone test does not apply, because it then gives an erroneous result, showing more rubber present than is a fact. I think it unwise to adopt that acetone test as final unless the test can be easily changed without long delay when it becomes known that some relatively new rubber compounds are improvements on the old ones to which old ones alone the acetone test applies.

Mr. Barrier. MR. BARRIER.—I think that is true of all specifications of the Society; they can be revised at any time, and the committee expects that there will be a great many revisions in their specifications because the chemistry of rubber is advancing very rapidly. It is the opinion of the committee, however, that at present these specifications represent the best practice we can recommend.

MR. JOHN B. TUTTLE.—There are three points that I want to suggest for consideration before the final vote. The first is in reference to the proposed Standard Specifications for $2\frac{5}{8}$-in. Cotton Rubber-Lined Fire Hose for Private Department Use, Section 2 (*b*), which specifies "pure fine Para rubber or its equivalent." The question of "its equivalent" is not so definitely settled as to justify the use of that expression in a specification. The experience on the Panama Canal has been that wherever the words "its equivalent" have been used, a lower grade than the rubber desired was secured in deliveries. Mr. Tuttle.

Secondly, in Section 3 (*d*) it is specified that "The compound used shall not contain more than 7.5 per cent of sulfur, exclusive of that which may be contained in the mineral matter, as barytes." The chemical tests are given for all determinations except that of barytes. This would leave the manner of conducting the latter test open to the decision of the testing laboratory, and a difference of method might very readily give a difference in the results.

The third point is in reference to the proposed Standard Methods for Testing of Cotton Rubber-Lined Hose. The limits on check analysis given in Section 16 are calculated as percentages of the gum present as found by analysis, and this means that the work must be done so accurately that there are probably few laboratories which would care to guarantee to give results that would check as closely as required. I presume that this will be a 40-per-cent compound, and therefore the organic-acetone extract must check within 0.04 per cent on the total compound (0.8 mg.), which is much closer than the average laboratory work and much better than a great many of the chemists can do as a matter of routine work. I would suggest that these percentages be expressed on the entire compound and not on the gum as found by the analysis.

MR. BARRIER.—Answering the last objection: the reason for expressing the percentages of these different materials on the amount of gum rather than on the total compound is that the interpretation of the analysis should be based on the ratio of the various determinations to the amount of rubber. For instance, the organic-acetone extract, if expressed on the total compound, if nothing is said about the amount of rubber, does not mean any- Mr. Barrier.

Mr. Barrier. thing. It is the percentage of organic-acetone extract as related to the amount of rubber that is significant. That is also true of the free and the total sulfur. It is true that in a 40-per-cent compound, there will usually be about 40 per cent of rubber, and it is difficult to determine the amount of rubber very accurately, but the error introduced in the percentage when figured on the amount of gum should never be very great.

The committee feels that the advantage gained by expressing these ratios the way they should be to show their true significance, is greater than the small loss in accuracy. Of course, the figures can be expressed both ways, if necessary; it is simply a matter of calculation in any case. The determination is ordinarily made on the amount of the compound, and is figured over on the basis of the amount of gum.

Mr. Tuttle. MR. TUTTLE.—The chairman of the committee did not get the point I raised. I approve of calculating the percentage on the amount of rubber present, but the report provides for duplicate determinations, and says that they must check within so many points. These duplicate determinations must check within too narrow a limit. It is a matter of checks and not one of limits for specification purposes. In other words, if the limits are as stated in Section 16, the average laboratory will not have its duplicates check as closely as required, and that may lead to unnecessary complications.

Mr. Barrier. MR. BARRIER.—The only answer to that is that in my own laboratory we do check as closely as that, and evidently this is true in the laboratories of the other members of the committee.

Mr. Walker. MR. P. H. WALKER.—The committee on the analysis of certain rubbers, of the American Chemical Society, has certainly indicated that even with cooperative work these limits could not possibly be met. I think there was not a single analyst whose results are reported there that had duplicates as close as these limits proposed here. I am speaking from memory, and I would not make that statement positively; but I am quite sure that no two analysts working on samples that had been very carefully prepared, agreed anything like as closely as the limits here when figured back to the rubber.

Mr. Barrier. MR. BARRIER.—It is possible that different analysts might not have checked each other, but the same man ought to be able

to check his own figures within those limits. That is all that is called for in the specifications. Mr. Barrier.

MR. WALKER.—They didn't do it. Mr. Walker.

MR. HENRY F. MUER (*by letter*).—As a member of the Society, I beg to submit the following comments and criticisms of the proposed Standard Specifications for $2\frac{5}{8}$-in. Cotton Rubber-Lined Fire Hose for Private Department Use, and the proposed Standard Methods for Testing of Cotton Rubber-Lined Hose,[1] proposed by Committee D-11, these being based upon our experience at this laboratory (Mt. Prospect Laboratory, City of New York): Mr. Muer.

SPECIFICATIONS FOR $2\frac{5}{8}$-IN. COTTON RUBBER-LINED FIRE HOSE FOR PRIVATE DEPARTMENT USE.

Section 2 (*b*).—We believe the rubber should be specified as Vulcanized Rubber Gum by Volume.[2] The specification of "pure fine Para rubber or its equivalent" is not susceptible of any analytical proof generally accepted. The grade of rubber is determined by the chemical and physical tests. The word "Para" adds no significance.

Section 3 (*c*).—We prefer to determine the set after rupture on the test piece used for the tensile strength and elongation. The set is measured not less than one minute, nor more than one and one-half minutes after rupture and is expressed as a percentage of the ultimate determined elongation, since it is a function of the elongation. This ratio defines the degree of vulcanization. This method is applicable to all rubber goods on which a tension test is made, inasmuch as the full tensile strength and full stretch are developed for all materials. The *maximum* set is then compared as a ratio to the *maximum* elongation after the maximum load has been applied. This not only economizes time and test specimens, but produces values capable of generalization into principles of rubber compounding and manufacture.

Section 3 (*d*).—We believe total sulfur should be specified

[1] These specifications and methods appear in the 1915 Year-Book.—ED.

[2] See Gottsch, "The Specification of Vulcanized Rubber Gum by Volume and its Determination by a new Solution Method," *Journal of Industrial and Engineering Chemistry*, in press.

Mr. Muer. "in all forms," as it is impractical to separate sulfur in barytes when other forms of barium are present, such as barium carbonate.

Section 8 (*a*).—The twist specified is nearly three and one-half turns in a 50-ft. length. One and one-half turns seems to us to be the proper allowance.

It seems surprising that with a specification for percentage of rubber by weight the specific gravity of the rubber tube is not even mentioned, since such a specification permits of a variation of at least 50 to 80 per cent of vulcanized rubber gum by volume.

We note also that nothing is said concerning foreign matter. In what category will fibers, lampblack and insoluble foreign, organic, volatile, and combustible matter fall?

We think the specification should include the following additional items: (*a*) tensile strength across the seam, (*b*) tensile strength and elongation after dry heat test of two hours at 220° F., (*c*) friction loss of the water way, and (*d*) a tolerance clause of 5 per cent of the specified values.

We regret that space does not permit elaboration of the foregoing, but we would refer the committee, and others interested, to the latest revision of the specifications for cotton rubber-lined fire hose of the City of New York.

METHODS FOR CHEMICAL ANALYSIS OF RUBBER LINING.

Section 10.—To insure the acetone in the thimble being at the boiling point it should be specified that "the discharge of the syphon shall not interrupt the boiling of the solvent below."

Our experience using dry heat instead of steam for warming the extraction vessel avoids the introduction of condensed steam in the vessel and a constant or increasing weight upon drying is attained after two periods of one-half hour each.

Section 12.—The residue recovered by this method is alcohol-soluble rubber when no oil substitutes are present. The method used by us is more rapid, more convenient and less disagreeable than the other method, and saponifies nitrated oils as well as blown or vulcanized oils.

Section 13.—There is no necessity to evaporate to dehydrate silica. Mr. Muer.

Section 14.—The mineral fillers as determined by us will contain any fibers or insoluble organic matter in the compound as well as the so-called proteid matter of the raw rubber. The manufacturer has to allow for this proteid matter as well as the organic acetone extract and ash of the raw rubber in meeting specifications under our methods. We do not make these allowances or corrections. The compound *shall show* a definite amount of vulcanized rubber gum by volume.

Section 15.—A method should be described for the determination of specific gravity.

METHODS FOR THE PHYSICAL TESTING OF RUBBER LINING AND COTTON FABRIC OF RUBBER-LINED HOSE.

Section 20.—We use the Schopper ring test. Our objection to the bar test is the lack of any means of automatically registering the elongation.

Section 21.—We separate the rubber from the fabric at the uniform rate of one inch per minute, and automatically record the variation of the friction strength in pounds on the autographic recording device of the Schopper machine adapted for this test.

Section 22.—It should be stated that the distance between the points of gripping of the test specimen shall be 5 in. when the test piece is inserted.

Section 24.—See comments above on the specifications, Section 3 (*c*).

We think that methods should also be specified for (*a*) tensile strength across the seam, (*b*) dry heat test, and (*c*) friction loss of the water way.

REPORT OF COMMITTEE D-13

ON

STANDARD TESTS AND SPECIFICATIONS FOR TEXTILE MATERIALS.

During the early part of 1915 the Executive Committee of the Society organized Committee D-13 on Standard Tests and Specifications for Textile Materials and under date of March 18, 1915, the Secretary-Treasurer notified the various members of their appointment and designated an acting chairman. The committee consists of seventeen members, six producers and eleven non-producers; of the latter five are unattached experts.

The establishment of the committee was undertaken at the request of the cement-bag consumers and the rubber-tire manufacturers. The committee met on April 10, organized by the election of a permanent chairman, and determined to limit its activities for the present to the consideration of tests and specifications of bags and bagging materials and tire fabrics.

A sub-committee on each subject was formed. These sub-committees have met, reported to the regularly called meeting of the committee and the committee submits the results of its conferences as follows:

Bags and Bagging Materials.—The consensus of opinion is that specifications and standards for bags should be for the material of which the bag is made and should be as simple as possible. The condition at present is such that it will be necessary for the sub-committee to make an investigation of the various requirements and obtain further information before it can formulate any standards.

Tire Fabrics.—The sub-committee received from several of its members, and especially from the Bureau of Standards, some very valuable information supported by extensive tests upon tire fabrics. The fundamental principles upon which

the methods of testing in the various laboratories have been developed are so similar that a fair degree of uniformity already exists.

It was therefore possible to draft Tentative Tests for Automobile Tire Fabrics, appended hereto,[1] to be used during the coming year in order to obtain information with which the sub-committee may be enabled to take up later the problem of standard specifications.

The tests as proposed are incomplete and are presented to the Society, not for submission to letter ballot for adoption, but merely as tentative methods to serve as a working basis to secure greater uniformity during the coming year, and it is recommended that they be printed as such in the Year-Book. It is hoped that they may find extensive application by the manufacturers and consumers of tire fabrics. The committee invites the cooperation of all who use these tests and will welcome any suggestions or constructive criticism.

This report has been submitted to letter ballot of the committee, which consists of 17 members, of whom 16 have voted affirmatively, and 1 negatively.

Respectfully submitted on behalf of the committee,

W. D. HARTSHORNE,
Chairman.

D. E. DOUTY,
Acting Secretary.

[EDITOR'S NOTE.—For action taken on this report, see pages 30–31.

The proposed Tentative Standard referred to in the report, as amended at the annual meeting, appears among the Tentative Standards in the 1915 Year-Book.

For Discussion on the report, see following page.]

[1] These tests are not reprinted here, but they appear in the 1915 Year-Book.—ED.

DISCUSSION.

Mr. Hartshorne.

MR. W. D. HARTSHORNE (*Chairman of Committee D-13*).—At a meeting of Committee D-13, held on Friday evening, June 25, the following changes in the Tentative Tests for Automobile Tire Fabrics, appended to the report of the committee, were adopted by unanimous vote of the twelve members present:

1. Insert the following new Section 10:

IV. LENGTH.

"10. The length of a roll shall be determined by running the cloth over a measuring drum of known circumference, from which the yardage is registered by a dial or counter driven by a chain or other positive and non-slip mechanism. Just enough uniform tension[1] is to be used on the cloth to keep it running flat and true."

2. Change Section 10 to Section 11, and insert the following footnote to the last word, "count," in that section:

"A 10-in. steel "count scale" similar to an engineer's triangular scale, graduated with teeth 1 in. apart on one edge and to the specifications of the cloth on the others,—for example, 23 teeth per inch on the second and 23 teeth per inch with each inch indicated on the third edge, as shown in Fig. 2,—will be found convenient, rapid, and accurate for making this measurement when used in the manner of a machinist's thread gage. The chairman will furnish any information desired regarding this count scale."

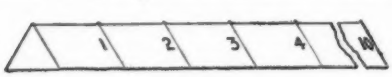


FIG. 2.

[1] It has been suggested that a uniform tension of 2.5 times the weight of five running yards of the fabric will be sufficient to keep the fabric flat and preserve a proper relation for comparison of different fabrics. Invitation is extended to report to the committee the results of such tests upon different fabrics.

REPORT OF COMMITTEE E-1

ON

STANDARD METHODS OF TESTING.

Committee E-1 has held four meetings since the date of the annual meeting of the Society in June, 1914.

The committee has had a number of subjects under consideration, and has prepared, and proposes for adoption by the Society, the following:

I. Methods for Brinell hardness tests of metals.

II. An addition to the present Standard Methods for Tension Tests giving the proper dimensions of tension test specimens for metal $\frac{1}{4}$ in. or under in thickness.

III. Certain changes in the present Standard Methods for Tension Tests, regarding the manner of using extensometers when determining the modulus of elasticity, the proportional limit, or the elastic limit.

IV. Certain changes in the present Standard Methods for Tension and Compressive Tests, defining correctly proportional limit, elastic limit, and yield point, and correcting those portions of the methods which involve a wrong use of these terms.

V. Miscellaneous minor changes in the present Standard Methods for Tension Tests.

These are hereby presented in detail.

I. It is recommended that the following proposed Standard Methods for Brinell Hardness Tests of Metals be added to the Standard Methods of Testing:

METHODS FOR BRINELL HARDNESS TESTS OF METALS.

1. *Chemical Composition and Heat Treatment of Balls.*—(*a*) The chemical composition, as far as carbon and chromium are concerned, should be from 1 to 1.2 per cent of carbon, and from 1 to 1.5 per cent of chromium.

(*b*) The heat treatment should be such as will result in making the balls as hard as possible, consistent with the ability to resist the pressure without cracking or crushing.

While a long series of careful experiments would be needed to justify the specifications of more exact conditions in these regards, and while some users of these tests think that the chemical composition (within limits) plays a very small part, if any, in the problem, it is believed that the above requirements will be found satisfactory for commercial work, until such time as suitable experiments shall have furnished the data necessary for making the conditions more precise.

2. *Diameter and Form of Balls.*—The standard diameter of balls should be 10 mm. with a permissible variation of 0.0025 mm. (0.0001 in.) plus or minus; no ball either new or old showing a greater variation is to be employed. The standard diameter should always be employed, except in very rare cases when some other is absolutely necessary. If, at any time in testing, a hardness of No. 600 be exceeded, the balls should be remicrometered.

Thus far there is not sufficient evidence to show that the hardness numbers will be the same when different diameters of balls are used, and some of the evidence indicates that the reverse is the case; hence the importance of adhering to one size of ball.

3. *Pressure.*—The standard pressures used should be 3000 kg. for steel, and 500 kg. for softer metals. Departure from these pressures should never be tolerated, except in rare cases where it is unavoidable. The time of pressure should be at least 30 seconds.

The fact that, with our present light on the subject, we can only regard the results as comparative, renders it important to employ as few different pressures as possible.

4. *Measurement of Diameter or Depth of Indentation.*—Whether the diameter or the depth of the indentation is measured, apparatus should be used that will give results as accurately as a microscope mounted on, and moved by, a micrometer screw.

As to the choice between the two, there exists a very decided difference of opinion, some thinking one and some the other more conducive to accuracy. The source of error in either case (assuming the measuring apparatus to be accurate) is the depression or the elevation of the metal immediately surrounding the indentation.

II. It is recommended that the following paragraph be added to present Section 2 of the Standard Methods of Testing, page 355 in the 1914 Year-Book:

> "In the case of flats $\frac{1}{4}$ in. or under in thickness, the dimensions shall be as follows: Width equal to 5 times the thickness of the specimen, except that in no case shall the width be less than $\frac{3}{4}$ in.; gage length equal to 24 times the thickness of the specimen, except that in no case shall the gage length be less than 2 in."

III. It is recommended that the following changes be made in the manner of using extensometers in the Methods for Tension Tests:

(*a*) Strike out Section 6, page 356 in the 1914 Year-Book, namely:

> "6. Within the limits of speed customary in determining the modulus of elasticity, it does not appear that the rate of loading influences the value obtained, but whether this value be determined by an autographic attachment to the machine, or by an extensometer on the specimen, it is desirable that the loading be not too rapid, or not over 0.05 in. per minute, to avoid impairing the accuracy of the sensitive devices employed.",

and substitute the following:

> "6. The standard method of determining the modulus of elasticity should be as follows:
>
> "Attach the extensometer to the specimen at the ends of the gage length—not to the shoulders, nor to any part of the testing machine—and at each end, at points on two opposite sides of the specimen in the case of flats, and at three equidistant points in the case of rounds.
>
> "Stop the machine after each increment or decrement of load long enough to take the readings.
>
> "If it is proposed to determine the modulus of elasticity by means of an extensometer with a continuous motion of the testing machine, by making its speed extremely slow, the speed that can be adopted should be determined in each case by comparison of the results with those obtained by the standard method as described above.
>
> "There is no intention to abolish the use of any extensometer whether it has two or three-point contact, but only to furnish a standard by which the efficiency of any extensometer can be gaged."

(*b*) Strike out Section 7, page 356 in the 1914 Year-Book, namely:

"7. In determining the modulus of elasticity, the elastic limit (the load at which stress and strain are no longer proportional), and the least load producing a given permanent set, it is considered necessary that the extensometer be attached to two sides of the specimen, to compensate for unequal elongation, for improper holding, or for any slight bending that may exist in the specimen.",

and substitute the following:

"7. In determining the modulus of elasticity, the elastic limit, and the proportional limit, it is considered necessary that the extensometer be attached at each end, in the case of flats, at points on the two opposite sides of the specimen, and in the case of rounds, at three equidistant points, in order to compensate for unequal elongation, for improper holding, or for any slight bending that may exist in the specimen; and further, that all tests where the elongations between two successive loads, as measured on the two or three gage lines, differ considerably from each other, shall be rejected."

(*c*) In Section 8, page 356 in the 1914 Year-Book, change "on the two sides of the test piece" to read "on the two opposite sides of the test specimen in the case of flats, and on three equidistant gage lines in the case of rounds."

(*d*) In Paragraph (*c*), page 360 in the 1914 Year-Book, change "on opposite sides of the specimen" to read "on two opposite sides of the specimen in the case of flats, and on three equidistant gage lines in the case of rounds."

IV. (*a*) It is recommended that the following section be inserted at the beginning of each of the Methods for Tension and Compression Tests, to be numbered Section 1, the numbering of the other sections being changed successively to correspond:

"1. *Definition of Terms.*

"*Elastic Limit* is the least load per square inch which produces a permanent set as indicated by an extensometer with a degree of precision of 0.0001 in., using the method hereafter described.

This determination is rarely made in the commercial testing of materials.

"*Proportional Limit* is the load per square inch where stress (load per square inch) and deformation (elongation) per unit of length cease to be proportional to each other, the deformation being determined by an extensometer with a degree of precision of 0.0001 in., by the method hereafter described.

This determination is rarely made in the commercial testing of materials.

"*Yield Point* is the load per square inch at which a distinctly visible increase occurs in the distance between the gage marks on the test specimen, as observed by using accurate dividers or an equivalent instrument, or at which, when the load is increased at the rate hereafter specified, there is a distinct drop of the beam of the testing machine.

This determination is made in the commercial testing of materials and is frequently incorrectly expressed as elastic limit."

(*b*) In Section 8, Methods for Compressive Tests of Metals, page 361 in the 1914 Year-Book, line 1, change "elastic limit" to read "the elastic and also the proportional limit.";

In line 5, strike out the word "elastic."

(*c*) In Sections 10 and 11, page 362 in the 1914 Year-Book, change "elastic limit and yield point" to read "elastic limit, proportional limit and yield point."

V. It is recommended that the following miscellaneous changes be made:

(*a*) In Section 14, Methods for Tension Tests of Metals, page 357 in the 1914 Year-Book, change "softer" to read "more ductile."

(*b*) In Section 1, "Conditions to Ensure Correct Testing Machines," page 357, in the 1914 Year-Book, line 16, strike out the words "at the Watertown Arsenal."

(*c*) Strike out Section 4 (*f*), page 358 in the 1914 Year-Book, namely:

"(*f*) The length of the bar measured by the extensometer shall be sufficient, that the smallest extensometer division will correspond to a difference in loading of 100 lb. or less.",

and substitute the following:

"(*f*) The length of the bar measured by the extensometer shall be sufficient that the smallest extensometer

division, that is, 0.0001 in., shall correspond to a difference in loading of 0.2 per cent of the capacity of the machine, or less."

Attention is called to the fact that the term "elastic limit" in a sense that should be expressed as "yield point" is used in only five specifications of this Society. If the definitions of elastic limit, proportional limit, and yield point proposed by the committee are approved, the term "elastic limit" in these specifications should be changed to read "yield point" in order to harmonize with these definitions.

This report has been submitted to letter ballot of the committee, which consists of 19 members, of whom 16 have voted affirmatively, none negatively, and 3 have refrained from voting.

Respectfully submitted on behalf of the committee,

GAETANO LANZA,
Chairman.

[EDITOR'S NOTE.—For action taken on this report, see page 19.

The proposed amendments in the Standard referred to under Sections I, II and V in the report were adopted by letter ballot of the Society on August 21, 1915. The Standard as amended appears among the Standards in the 1915 Year-Book.

The proposed amendments under Sections III and IV of the report appear among the Tentative Standards in the 1915 Year-Book.]

DISCUSSION.

MR. C. E. SKINNER (*presented in written form*).—The writer wishes to protest against the adoption of the proposed standard method of determining the modulus of elasticity, elastic limit and proportional limit. Commercial practice of a number of years has proved that entirely satisfactory results can be obtained by the use of an extensometer attached to the specimen at two points and read without stopping the testing machine. This method was described by the writer before the International Association for Testing Materials at its New York Congress in 1912, was also discussed by Mr. Lynch at the annual meeting last year, and is fully described in Mr. Lynch's paper under the title "Elastic Limit," this year.[1] The method proposed is impracticable for commercial work and if adopted would have to be disregarded by those who desire to use the extensometer for regular commercial testing. The proposed method may be more accurate than that referred to by the writer, but we have ample evidence that the latter is sufficiently accurate for all practical purposes. It is sufficiently rapid so that all tests of any importance whatsoever, made in our laboratory, are made by this method. Mr. Skinner.

We believe that the clause should be so worded as to admit of any method which will give the requisite degree of accuracy and that the degree of accuracy of reading should be the basis of the specification rather than the exact method of carrying out the tests. We believe that the adoption of a detailed method such as this will be a hindrance to progress rather than an aid. The extensometer properly used is of such great value in commercial work that we believe this Society should do everything in its power to extend the actual field of its use. I trust that the report of the committee may be changed to cover the performance of the extensometer, rather than to state a detailed method which limits it to a specific type of instrument.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part II, p. 415 (1915).—ED.

Mr. Lanza. MR. GAETANO LANZA (*Chairman of Committee E-1*).—I think it is rather unfortunate that Mr. Skinner, or anyone else who proposed to make any remarks of the sort, should not have presented them long ago. After reading Mr. Skinner's discussion, which I have just seen for the first time, I must say that it seems to me that the wording of the report allows all that he wants to do. If, however, he thinks otherwise, and had presented the matter three months ago, we might have been able to alter the wording so as to satisfy him.

It is plain that while the determination of the elastic limit requires the stopping of the machine to ascertain whether or not there is any set, the proportional limit can be obtained with a continuous motion, provided the observer takes pains to be sufficiently careful, and the measuring apparatus is suitable.

Moreover, if the specimen is straight and properly adjusted in the machine, the same result will be obtained with three-point, two-point, or one-point contact; but the special function fulfilled by the method proposed as a standard is that it enables us to ascertain whether the specimen is really straight, and properly adjusted in the machine.

Mr. Lynch. MR. T. D. LYNCH.—I had the pleasure of presenting a written discussion on this question at the convention last year, at which time I proposed a scheme by which I thought this subject would be made more clear than has been suggested by Committee E-1 in the report before you. It is apparent that if we adopt a two-point contact for flat specimens and a three-point contact for round specimens, confusion is sure to result, and duplication of apparatus would be made necessary.

Our experience during the past eight years in the continuous use of a two-point contact instrument, representing thousands of tests each year, has resulted in our firm belief that the accuracy thus obtained is sufficient for all practical purposes.

Our thought is that this report should be made in such modified form as will permit the use of a two-point contact instrument reading to 0.0001 in. per inch of length between gage points of the test specimen, this to apply to rounds as well as flats and squares. Permission should be given to run the testing machine continuously during the test when determining the

proportional limit or yield point, it being necessary to stop the machine when taking readings for determining the elastic limit. Mr. Lynch.

Some such plan as this would, in our opinion from a practical point of view, be far more valuable to the members of this Society than to establish tests that are practical only in the most completely equipped laboratories. The speaker believes that this Society stands not only for progressive methods, but methods that can be made use of in commercial work as well as in elaborately equipped laboratories.

MR. G. E. THACKRAY.—It strikes me that a part of this misunderstanding at this late day is occasioned by the fact that the title of this report is somewhat misleading. The fact is, as I understand it, that at all times during the discussion of this subject by the committee, it was understood that these so-called standard methods of testing are what are known as standard methods of technical testing, and are not standard methods of commercial testing. In order to make it clear, this was impressed upon the chairman from time to time by myself as a member of the committee, and by others of the committee, whereupon the remarks were made as follows and printed in paragraph IV, under the heading "Elastic Limit:" "This determination is rarely made in the commercial testing of materials." Again, the report says under the heading "Proportional Limit:" "This determination is rarely made in the commercial testing of materials." Under the heading "Yield Point," however, it says: "This determination is made in the commercial testing of materials and is frequently incorrectly expressed as elastic limit." These statements show the sense and intent of this report. In view of this fact and the other criticisms that have been made, I recommend that the proper mode of procedure in this affair would be to refer the matter back to the committee. Mr. Thackray.

A MEMBER.—It seems to me that the whole trouble is due to the fact that the committee is trying to combine in one standard method of procedure, a procedure for technical testing and one for commercial testing. Why not suggest to the committee that they bring forward next year two recommendations, one devoted entirely to technical testing, and one devoted entirely to commercial testing, and in this way satisfy everybody. A Member.

I may say in regard to this matter of the attachment of the

A Member. extensometer, Mr. Skinner has made a plea for the two-point method of attachment. The committee recommends the three-point method of attachment, I understand, for refined technical testing.

Mr. Thackray. MR. THACKRAY.—The question, as it appears to me, reduces to an absurdity. The report says you may use a certain and particular method provided it gives results as accurate as the other. Let us see how we shall determine whether the two-point method is as accurate as the three-point method. The only way we can discover that is by using the three-point method, which, it seems to me, is absurd.

REPORT OF COMMITTEE E-4

ON

METHODS OF SAMPLING AND ANALYSIS OF COAL.

It will be recalled that Committee E-4 forms part of a joint committee with a committee of the American Chemical Society on Methods of Sampling and Analysis of Coal. A preliminary report of the joint committee was presented to this Society at its June meeting in 1914. Committee E-4 hereby presents its second report to this Society, as appended.

This report has been submitted to letter ballot of the committee, which consists of 4 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

S. W. PARR,
Chairman

APPENDIX.

FINAL REPORT OF THE JOINT COMMITTEE ON COAL ANALYSIS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS AND THE AMERICAN CHEMICAL SOCIETY.

The joint committee which has been at work on the subject since the fall of 1911, consists of the following members: W. A. Noyes, *Chairman*, Perry Barker, H. C. Dickinson, A. C. Fieldner, Frank Haas, W. F. Hillebrand, S. W. Parr, S. S. Voorhees, and A. H. White.

The work of the joint committee has been carried on chiefly through the agency of the following sub-committees:

I. Preparation of Laboratory Samples, including Loss of Moisture in Sampling—Fieldner, *Chairman*, Haas, Hillebrand, Voorhees, Parr and Barker.

II. Moisture—Hillebrand, *Chairman*, Fieldner, Parr.

III. Deterioration—Parr, *Chairman*, Fieldner, Haas, Dickinson.

IV. Volatile Matter—Parr, *Chairman*, Fieldner, Haas, Dickinson.

V. Fixed Carbon and Ash—Parr, *Chairman*, Fieldner, Hillebrand.

VI. Sulfur—Barker, *Chairman*, Voorhees, Dickinson.

VII. Phosphorus—Hillebrand.

VIII. Ultimate Analysis—Fieldner, *Chairman*, Parr, White.

IX. Calorimetric Determination—Dickinson, *Chairman*, Haas, Barker.

Two preliminary reports have been published, one in the Journal of Industrial and Engineering Chemistry, Vol. 5, page 517, for 1913, and the other as the Report of Committee E-4

to the Society in 1914.[1] To the present report, which is submitted as the final report of the joint committee, proposed Tentative Methods for the Sampling and Analysis of Coal are appended.[2] They are recommended for the use of chemists and as a basis for specifications to be used in the purchase of the coal. (Many details given in the preliminary reports are not repeated here.)

This report has been referred to letter ballot of the joint committee, which consists of 9 members, all whom have voted affirmatively.

Respectfully submitted on behalf of the joint committee,

W. A. NOYES,
Chairman.

[EDITOR'S NOTE.—For action taken on this report, see page 15.

The proposed Tentative Standard referred to in the report, as amended at the annual meeting, appears among the Tentative Standards in the 1915 Year-Book.]

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, pp. 409–452 (1914).

[2] These methods are not reprinted here, but they appear in the 1915 Year-Book.—ED.

REPORT OF COMMITTEE E-5

ON

TECHNICAL COMMITTEES.

THE DUTIES OF THIS COMMITTEE ARE THE FORMULATION OF (*a*) REGULATIONS GOVERNING TECHNICAL COMMITTEES, (*b*) REGULATIONS GOVERNING THE FORM BUT NOT THE SUBSTANCE OF STANDARDS, AND (*c*) THE CLASSIFICATION OF STANDARDS.

This committee, heretofore known as Committee E-5 on Regulations Governing the Form but not the Substance of Specifications, has changed its designation, with the approval of the Executive Committee, to that of Committee E-5 on Technical Committees, with the understanding that the following explanatory statement shall be sub-joined to its title:

> The duties of this committee are the formulation of (*a*) Regulations Governing Technical Committees, (*b*) Regulations Governing the Form but not the Substance of Standards, and (*c*) the Classification of Standards.

Committee E-5 presents as its report this year the Regulations Governing Technical Committees in the revised form in which they appear in the appendix to this report. The italicized parts (except side headings) in this appendix represent new matter. The old matter which has either been canceled or superseded is shown stricken out, so that all changes in the regulations during the past year are apparent at a glance.

It is to be noted that Article VI, quoted from the by-laws, does not exist in the present by-laws; but its adoption will be recommended by the Executive Committee, subject to action at this, the Eighteenth Annual Meeting of the Society, and the subsequent letter ballot of the Society at large.

It is gratifying to state that no negative vote has been cast by any member of the Executive Committee or of Committee E-5 against any of the changes embodied in the appendix to this report.

This report has been submitted to letter ballot of the committee, which consists of 29 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

EDGAR MARBURG,
Chairman.

APPENDIX.

REGULATIONS GOVERNING TECHNICAL COMMITTEES.

NOTE.—By action of the Executive Committee on January 6, 1912, the responsibility for the general Regulations Governing Technical Committees is vested in Committee E-5 on ~~Regulations Governing the Form but not the Substance of Specifications~~ *Technical Committees*, with the understanding (1) that a proposed change in these Regulations originating with Committee E-5 shall be subject to approval by the Executive Committee of the Society; and (2) that the Executive Committee of the Society shall make no changes in these Regulations without first referring the same to Committee E-5.

Creation.—The creation of a technical committee shall be subject to the authorization of the Executive Committee, acting either on a recommendation adopted by majority vote at an annual meeting of the Society, or on its own initiative.

Appointments.—Appointments on technical committees shall be made by the Executive Committee subject to the following provisions:

1. On committees dealing with subjects having a commercial bearing, either an equal numeric balance shall be maintained between the representatives of producing and non-producing interests; or the latter may be allowed to predominate with the acquiescence of the former.

2. The classification of the members of a committee into producers and non-producers shall be left to each committee, subject to the following provisions, and with the understanding that a member dissatisfied with ~~his~~ *this* classification has the right of appeal to the Executive Committee:

   (*a*) A member who stands in the relation of producer to any product within the province of the committee shall be classed as a producer, although at the request of the officers of the committee con-

cerned, attention shall be called to the status of such members in a footnote worded as follows:

These members of Committee..... classed as PRODUCERS, stand in the relation of PRODUCERS to certain products, and in that of NON-PRODUCERS to other products within the province of the committee.

(*b*) A nominally unattached expert, who is permanently retained by producing interests in the field of activities of the committee with which he is connected, shall be classed as a producer. *The qualification "permanently retained" is to be understood to mean that the expert receives a regular monthly or yearly retainer from one or more producing interests under an indefinitely continuing arrangement.*

~~3. Only one representative from a given firm, company, corporation, laboratory, or other institution shall be eligible on a given committee, but if that membership is held in the name of the firm, company, corporation, laboratory, or other institution, more than one representative may, at the discretion of the committee concerned, participate in its activities, with the understanding that such representatives shall jointly command only a single vote. In the case of corporations or government branches whose policy does not admit of their holding membership in the Society under their corporate or official name, an exception to this rule may be permitted at the discretion of the committee concerned.~~

3. *As a general policy, only one representative from a given firm, company, corporation, laboratory, or other institution shall be eligible on a given committee, although exceptions to this rule may be permitted at the discretion of the committee concerned.*

4. Additional appointments on existing committees shall be made only on the recommendation of, or with the approval of, such committees.

5. Only members of the Society shall be eligible, in general, to appointment on committees, although exceptions may be authorized by the Executive Committee in favor of representatives of government branches or other societies.

Preliminary Organization.—The President of the Society will appoint the chairman *pro tem.* of a new committee from the representatives of the non-producing interests. The chairman *pro tem.*, after communicating with the other members of the committee, will fix the place and time of the first meeting. He may, at his discretion, appoint one or more members of the committee to prepare matter in advance for consideration at that meeting or he may prepare such matter himself. This procedure is recommended as calculated to economize time at the meeting and to afford a definite basis for discussion.

Permanent Organization.—At the first meeting of a committee a permanent organization shall be effected by the election of a permanent chairman from among the representatives of non-producing interests, and such other officers and sub-committees as the committee may desire. The duties and powers assigned to these officers and sub-committees, and the details of management and administration in general, shall be at the discretion of each committee, subject to the limitations of these regulations.

Election of Officers.—Every technical committee shall hold an election of officers at or before the ~~1914~~ annual meeting of the Society *occurring in the even years.* The term of office of every officer shall be two years and officers shall be eligible for re-election.

Resignations.—Proposed resignations from office or from membership on a technical committee shall be reported directly to the chairman or the secretary of the committee concerned, and the result of any action taken in such matters shall be reported to the Secretary-Treasurer of the Society.

Sub-Committees.—Sub-Committees on proposed standards shall consist of not fewer than six members, and at least one-half of the membership shall be composed of non-producers.

Reports.—The reports of technical committees shall be presented at the annual meetings. Such reports must first have been submitted to letter ballot of the committee and must have received the approval of the majority of those voting. A statement of the following form shall appear at the close of every committee report:

> This report has been submitted to letter ballot of the committee which consists of ..... members, of whom ..... have voted affirmatively, ... negatively, and ..... have refrained from voting.

Dissenting members shall have the right to present minority reports individually or jointly.

Standards.[1]—*The term "Standards" shall be applied collectively to (a) standard specifications, (b) standard tests, (c) standard methods, and (d) standard definitions.*

The term "Standard Specifications" shall be applied to specifications designed to govern the purchase of materials. Such specifications may or may not include reference to tests, but they shall include limits for physical, chemical or other properties.

The term "Standard Tests" shall be applied to prescribed directions for tests of specific materials, but shall not include limits for physical, chemical or other properties.

The term "Standard Methods" shall be applied to prescribed methods of procedure in the conduct of physical, chemical or other tests.

The term "Standard Definitions" is self-explanatory.

~~*Specifications.*~~—Proposed new standards ~~specifications~~ or the proposed amendment of existing standards ~~specifications~~ must originate in the particular committee within whose province such ~~specifications~~ *standards* properly belong. No action affecting ~~specifications~~ *standards* shall be taken by any technical committee except at meetings called for that purpose. Action at such meetings shall be subject to majority vote of those voting, and subsequently to majority vote of those voting on letter ballot of the entire committee. The results of each letter ballot as to the number of affirmative votes, the number of negative votes, and the number of members not voting, shall be announced in the report of the committee to the Society. Dissenting members shall have the right to present minority reports, individually or jointly, at the annual meeting of the Society at which the majority report is presented.

Any recommendations affecting ~~specifications~~ *standards* must be transmitted to the Secretary-Treasurer of the Society at least eight weeks in advance of the date of the annual meeting, and copies of these recommendations, in printed form, must be mailed by the Secretary-Treasurer to every member of the Society not less than four weeks before the annual meeting, so that members may come to the meeting prepared to discuss such recommendations, and that members not intending to be present at the meeting may contribute discussions by letter.

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[1] These definitions of standards will become effective only upon the adoption of the subsequently quoted proposed new Article VI of the by-laws (see footnote on p. 462).

~~Any recommendations affecting specifications presented by the appropriate committees at the annual meeting of the Society may be amended as prescribed in the by-laws, and the final adoption of new or amended specifications shall be subject to the following procedure, also prescribed in the by-laws.~~

~~1. Approval at an annual meeting by two-thirds vote of those voting;~~

~~2. Approval by letter ballot of the Society by two-thirds vote of those voting.~~

~~*Definitions.* The procedure governing action on proposed new standard definitions or proposed amendment of existing standard definitions shall be in precise conformity with that above defined in relation to "Specifications," except that, as prescribed in the by-laws, such new or amended definitions shall not be referred to letter ballot of the Society prior to the annual meeting following their publication in the Proceedings.~~

Any recommendations affecting standards presented by the appropriate committees at the annual meeting of the Society will be subject to the following provisions in Article VI of the by-laws:

PROCEDURE GOVERNING THE ADOPTION OF STANDARDS.[1]

The term "Standards" shall be applied collectively to standard specifications, standard tests, standard methods, and standard definitions.

Proposed new standards or proposed amendments of existing standards shall be presented at the annual meeting. At this meeting amendments may be made by a two-thirds vote of those voting. The proposed new standards or the proposed amendments of existing standards, as presented or as amended, shall be printed, on two-thirds vote of those voting, in the Year-Book under a section designated "Tentative Standards," on which written discussions addressed to the appropriate committee shall be invited. At the next annual meeting these proposed new standards or proposed amendments of existing standards shall be subject to amendment by a two-thirds vote of those voting, and to reference by a like vote to letter ballot of the Society. A two-thirds vote of those voting shall be required for adoption.

The above requirement by which final action on proposed new

[1] As stated in the report of Committee E-5, this Article of the by laws does not exist in the present by-laws, but its adoption will be recommended by the Executive Committee, subject to action at the Eighteenth Annual Meeting of the Society (1915), and the subsequent letter ballot of the Society at large.

standards or proposed amendments of existing standards shall be deferred for one year may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the annual meeting at which they are first presented. In that case the above provisions as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected.

The term "Recommended Practice" shall be applied to processes and methods not ordinarily subject to contract between purchaser and manufacturer. The above requirements governing action on new standards or proposed amendments of existing standards shall be applicable also to proposed Recommended Practice.

Cooperation with Other Committees.—A committee may, at its discretion, invite the cooperation of committees of other societies on like or cognate subjects, provided such relations shall entail no obligations at variance with these regulations, and shall impose no restrictions upon the free and independent action of the committee.

A committee desiring to bring about the appointment of similar committees by other societies for purposes of cooperation shall address a recommendation to that effect to the Executive Committee and, on the approval of the latter, negotiations to the desired end shall be conducted on behalf of the Executive Committee by the Secretary-Treasurer of the Society.

Publication.—Committees shall have no right to issue matter for publication through other than the regular Society channels, unless so authorized, for exceptional reasons, by the Executive Committee.

Current Expenses.—Expenses for postage incurred in connection with the business of committees will be refunded by the Secretary-Treasurer of the Society on vouchers approved by the chairmen of these committees.

Stationery.—Correspondence relating to the business of committees or sub-committees shall be conducted on official stationery which will be furnished by the Secretary-Treasurer of the Society.

Extraordinary Expenses.—Expenses for items other than postage will not be assumed by the Society, unless such expenditures were incurred in pursuance of previous authorization of the Executive Committee, on recommendation of the chairman of the committee concerned, and within amounts specifically fixed by the Executive Committee.

Special Funds.—Committees engaged on subjects having a commercial bearing shall be authorized to solicit contributions

from manufacturers towards research funds. Contributions from consumers to funds for this and other purposes shall be solicited only by the Executive Committee. All funds thus collected shall be transmitted to the Secretary-Treasurer of the Society and deposited by him in bank and placed to the credit of the committees on the books of the Society, subject to disbursement only on vouchers signed by the chairman of the committee concerned.

Salaries and Fees.—Committees shall not be authorized to pay salaries or professional fees in any form to any of their officers or members. Assistants in connection with research work may be engaged at salaries or special compensation fixed by the committees concerned, provided that funds for such salaries or compensations shall previously have been deposited with the Secretary-Treasurer of the Society. Payments for such purposes shall be made by the Secretary-Treasurer of the Society only on vouchers approved by the chairman of the committee concerned.

Discharge of Committees.—Technical committees may be discharged by the Executive Committee, either at their own request or with their consent, on the completion of the work for which they were appointed or in consequence of protracted inactivity. A technical committee which fails to present a report at three successive annual meetings of the Society will be required to show cause, in a written communication to the Executive Committee, why it should not be discharged.

Technical committees may be discharged for cause by the Executive Committee at its own initiative.

AMERICAN REPRESENTATION ON COMMITTEES OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

Nominations.—In making nominations for appointment of American members on International committees on a subject, falling within the province of an American technical committee, the sense of the latter committee as to the selection of the nominee shall be obtained before final action on the part of the Executive Committee.

Relation between American Representatives on International Committees and American Committees on the same Subjects.—The American representative or representatives on an International committee dealing with subjects falling within the province of an American technical committee shall keep that committee

fully advised as to the important developments in the work of the International committee. Formal recommendations to the International committee on the part of such representative or representatives, and their vote on letter ballot of that committee, shall be subject to advance approval on the part of the American committee.

RECOMMENDATIONS TO TECHNICAL COMMITTEES.

The following recommendations to technical committees have been approved by the Executive Committee and Committee E-5:

It is recommended that the various technical committees should formulate proposed standard definitions of terms in matters falling in their respective fields, and that in the case of terms which come within the province of two or more committees, such definitions be formulated by joint action, through sub-committees, on the part of the committees concerned. Such proposed standard definitions of terms will be subject to adoption by the Society under the provisions of the by-laws and the Regulations Governing Technical Committees.

An alphabetic glossary of standard definitions of terms will be published in the Year-Book as soon as their number appears to warrant such action.

REPORT OF COMMITTEE E-6

ON

PAPERS AND PUBLICATIONS.

Since the last annual meeting there has been no occasion to hold a general meeting of Committee E-6. Its functions relative to the acceptance of papers have been discharged by the Advisory Committee and other members of the committee who have given individual expert advice. The committee has also received assistance of this kind from members of the Society not connected with the committee, for which it desires to record its appreciative acknowledgment.

In view of financial conditions and in order to afford better opportunity for discussion, the Executive Committee instructed Committee E-6 to endeavor to reduce the scope of the program for this annual meeting, in so far as that might be found feasible with due regard to the best interests of the Society. In pursuance of these instructions the Advisory Committee, after allowing a liberal extension beyond the limiting date announced by the Executive Committee, has declined numerous offers of papers received after the expiration of this extension. It has also been found necessary to decline, for various reasons, certain offers received at an earlier date, as well as several papers which had been provisionally accepted by title. Notwithstanding the efforts to carry out the instructions of the Executive Committee within the limits prescribed, the material in view for this meeting aggregates 968 pages, as compared with 939 pages last year.

The usual vigorous efforts have been made this year to have all of the matter presented at this meeting preprinted and circulated in advance among the members of the Society at large. All of the 27 committee reports and 24 papers included in the final program for the annual meeting, totaling 968 pages, have been printed in advance of the meeting. With the exception of 3 committee reports and part of a fourth, and 4 papers,

all of this printed matter has been distributed as part of three instalments of preprints, of which the first was issued four weeks, the second 11 days, and the third 5 days before the opening date of the meeting.

The comparative data for preprints since 1913, when preprinting was first undertaken on an extensive scale, are as follows:

Year.	Preprints.			On Program, but not Preprinted, pages.
	Circulated in Advance, pages.	Not Circulated in Advance, pages.	Total, pages.	
1913	461	238	699	81
1914	668	260	928	11
1915	891	77	968	0

The effect of the policy of advance distribution of matter to be presented at annual meetings as indicated by the increased volume of discussion has been reported in detail in the annual report of the Executive Committee, and the committee will therefore content itself with directing attention to this analysis.

This report has been submitted to letter ballot of the committee, which consists of ten members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

EDGAR MARBURG,
Chairman.

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